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Comment

Progress of persuasion

There can be few areas of medicine like organ transplantation where movement towards the greater availability of treatment has been so hampered by external hindrances. The desperate need in Britain for human kidneys has prompted the British Transplantation Society to look simultaneously at the entire range of ethical and social problems, in addition to the medical aspects, associated with organ transfer from donor to recipient. The society formed a committee which, very sensibly, included a doctor working as a journalist and two non-scientists, namely a bishop and a lawyer. The British Medical Journal (vol 1, 1975, p 251) has performed a valuable service in publishing the committee's report.

The document should receive a warm general welcome, even from the opponents of transplantation. Emphasis is laid on the use of kidneys. The authors discuss anxiety felt within the medical profession over the position of the doctor whose patient has just died, and has thus become a potential donor. Doctors are afraid both of contravening the law as they understand it, and of invoking hostility from relatives of the deceased. Accordingly, a code of practice is advanced, in which the importance of the establishment of brain death prior to organ removal is stressed. The code is careful to keep within existing law; even if the deceased carried a transplant donor card, the wishes of bereaved relatives are paramount. If new legislation, introduced into the House of Commons for no less than the fifth time in recent years, becomes law, certain aspects of the code may require revision.

One additional point ought to be emphasised. The majority of potential donors comprises individuals who are either demonstrably alive or unambiguously dead. Where doubt arises, the number of cases is small. If indeed the public senses, however wrongly, that undesirable pressures exist in the management of patients on the borderline, it follows that the greatly improved supply of kidneys in good order automatically resulting from proposed changes in the law would relieve any unjustified anxiety on this score.

Cautiously and properly, the report is advanced as a document for discussion between doctors and the lay public. As such, the work needs all possible publicity, and more. The media therefore have a vital role not only to inform responsibly, but also to dissect out and expose the basic arguments for and against. However, if the alternative to the transplant has to be the lingering, premature death of a young parent, the majority of the public will find little sympathy with opponents motivated by extremes of religious faith.

The greatest single factor in securing further public support for kidney transplantation will undoubtedly prove to be its success. The techniques are now well enough established to have lost the stigma of the experimental stage. Significantly, kidney transplants are now sympathetically discussed by a lay press which at one time betrayed elements of hostility. For many reasons it is incomparably better that patients with kidney disease receive stable, viable organs than continue with dialysis, which is lifesaving but stressful (New Scientist, vol 56, p 326). Yet, because donor kidneys are not excised sufficiently quickly, the quality of the donor's gift may be unacceptably poor. The report states that one-sixth of kidneys transplanted in Britain fail to function in the recipient. Prompt excision after death is one way in which this highly unsatisfactory situation could be improved. Meanwhile, as the extra-medical problems that encumber transplantation are slowly resolved, surgeons must not fail to recognise, encourage, and promote the essential supportive part played by the non-medical scientist in transplant research. *Robert Jones*

Double-handed treaty

The Treaty of Rome (Articles 30, 85 and 86) prohibits anything likely to restrict or distort free trading between member states of the EEC. The same treaty (Articles 36 and 222) exempts industrial property rights (such as those afforded by patent, design, and trade mark monopolies) from any such provisions. In other words, the treaty lifts all barriers between member states yet at the same time leaves some of them untouched. Does this not make it a nonsense and a lawyer's dream?

Inventors with new ideas to patent and trade marks and designs to register, and manufacturers worrying about other people's existing monopolies, are currently utterly confused over how existing British laws are affected by the Treaty of Rome and whether they are likely to be overriden by the Community Court. Likewise, it would be a brave or foolish patent agent or lawyer who offered any positive advice without reservations.

Recent European court decisions on industrial property have created a cobweb of contradictions. By far the most crucial is the question which daily confronts all but the richest manufacturer with an invention to patent or a design or trade mark to register. If protection is sought in the UK only, or in the UK and only some of the other EEC states, what will the paper monopoly which the applicant is granted be worth in the eyes of the European court? We now know that in certain circumstances the court will allow the same trade mark to be used on the same goods by different companies in an EEC state. This makes a nonsense of the whole object of trade mark law. Also, where a price differential (for instance as generated by NHS action on a drug) exists between two EEC countries, a manufacturer holding patents in both countries will be powerless to stop an entrepreneur buying the patented product in the cheaper country and selling it at an intermediate price to make a profit in the other country.

Although the Commission has handed down a tablet of stone (Official Journal of the European Communities, vol 17, C90, p 10), reassuring inventors that if they hold a patent in only one or a few of the EEC states they should be able to prevent the importation into those states of articles made by infringers elsewhere in the EEC, a big question mark hangs over another everyday situation. If a British manufacturer, through choice or lack of funds, patents only in the UK but manufactures elsewhere in the EEC, can he prevent an opportunist buying up his products cheaply on the Continent and importing them?

Manufacturers are beginning to realise that questions like these affect them *now* and that what happens in the future, about Munich and the Europatent, is another, quite separate issue. Bewildered businessmen are currently flocking to seminars on EEC Industrial Property Law, where authorities pontificate on possible answers to burning questions. What most of the businessmen want, however, is the chance to grill a member of the Commission at first hand. Unfortunately, members always seem too busy to attend seminars. Now that the firm promise of a British referendum on the Treaty of Rome has been announced, will the Commission—before the referendum, not after—do Britain the favour of sending over a one-armed industrial property lawyer, who will find it physically impossible to talk about things being on the one hand this way, and on the other hand that way?

Adrian Hope

Amenity trees

A recent survey around Edinburgh has revealed a large and important resource of native and exotic amenity trees, which need as thoughtful management as their counterparts in commercial forests, woodlands and orchards. Edinburgh, with a human population of about 470 000, in 1972 maintained 870 000 trees over 1·8 m in height. The distribution of these trees is particularly interesting. Over 90 per cent occur in private gardens, with park and street trees representing only a small fraction of the total. Apple, lilac, flowering cherry, rowan (moutain ash) and cypress were the commonest types in gardens; whitebeam, sycamore, flowering cherry, hawthorn and crab apple in streets; and elm, sycamore, whitebeam, lime and ash were the most abundant in parks. In areas of predominantly rented accommodation there was only one tree per household, while in areas dominated by owner-occupiers there were eight times as many trees.

In 1974 the survey was extended to the predominantly rural county of East Lothian. We estimated that there are 2 000 000 ± 380 000 amenity trees in East Lothian—a figure which, like that for Edinburgh, is rather more than we expected. But contrary to the commonly held belief, there were only half as many amenity trees per hectare in the largely rural East Lothian as in urban Edinburgh: 30 compared with 60.

Within this population of amenity trees there is a disturbingly low proportion of saplings to mature trees; at least parts of the resource are already in jeopardy. In East Lothian, although the size-class distributions suggest that populations of some species (eg sycamore and wych elm) will be maintained, the data for others (eg oak and lime) give cause for concern. Oak is in a particularly alarming position, since this tree as well as having a special place in our history and customs, acts as host to more species of insects and other invertebrates than any other plant.

There is an increasing awareness today of the contribution of non-economic trees to our general well-being. They contribute to the landscape decoratively, they act as historical markers of ancient boundaries and former land-use practices; they are recognised as havens for wildlife, and as shelter belts; and they have a definite if limited value as sources of veneer timber and firewood.

There is an increasing need for these roles to be harmonised, and to achieve this a coherent management strategy will be required. Some of its elements may at first seem novel. For example, how does one best encourage houseowners to plant and maintain amenity trees? Again, which species are best for towns? Vandalism is the scourge of tree planters in many urban areas. Our survey of Edinburgh showed that elder and lilac, unlike most other trees, were able to survive equally well in all localities. With the possible addition of hawthorn and pussy willow (sallow), perhaps these are the trees which should be planted in such areas, instead of the traditional cherries and rowans?

John Good and Fred Last
Institute of Terrestrial Ecology

What has happened to energy R & D?

Energy research and development is not something to rush into without first thinking about how best to spend money. But the Department of Energy's action on R & D is stunningly slow. The Department of Energy issued its report on research and development 1973-74 on Monday. This reveals a rise in spending on energy R & D from £112·073 million in the year 1973-74 to £122·051 million this year. (This is just about the same amount as the government spends on aerospace R & D.) It is also practically all that the report does tell us—it might meet the recommendation of the House of Commons Select Committee on Science and Technology that "all government departments with research and development activities should publish annual reports on these activities", but it does so with little enthusiasm and even less information. The report should bring together the government's energy R & D strategy and tell us of the direction in which that work is leading.

This report covers the period before the Department of Energy came into being; but we have had this department for over a year now. Dr Walter Marshall, who whizzed into the job as Chief Scientist with D.En last June, has been globe trotting in pursuit of good international relations on energy R & D; but there is, as yet, little sign that he has achieved much at home. This may be because he is finding the civil service a slightly less malleable entity than he hoped; but it might also be because R & D is not really taken very seriously down at Thames House South. Yet another interpretation is that the Department may be hiding some significant achievements and solid progress in producing a master plan for energy R & D in Britain. There has been a little progress visible on this front. For example, the study of the future of the country's coal industry by the National Coal Board, the Department of Energy, and the coal workers' unions presented a reasonable programme for future R & D in this sector, although the proposals have not gone uncriticised (Energy file, this issue, p 324). But Britain has done nothing to match the work of Dixy Lee Ray, who prepared the USAEC report on the future of energy R & D in the US; or Japan's "Project Sunshine", which is an example we could look at closely. Whatever the Department of Energy does, it must achieve spending increases far in excess of the miserable 10 per cent over the past year. With several ideas now poised to enter the costly pilot project stage, more money will be needed to sustain Britain's acknowledged stature in coal research, for example, which led to the International Energy Agency putting coal R & D coordination into British hands. And the reevaluation of hitherto uneconomic energy systems, such as tidal power and solar energy, may not be expensive individually, but a sensible review of Britain's energy options will be a costly exercise if it is to be thorough and authoritative. *Michael Kenward*

Monitor

Harwell wins £2.8m to expand nuclear research

Treasury go-ahead within 12 months of the original scientific proposal has been given to the UK Atomic Energy Authority to build a new, £2·8-million, 140-MeV linear electron accelerator at the Harwell nuclear research centre. The machine is to be commissioned by the end of 1977.

Dr Basil Rose, head of the nuclear physics group, says the move is a timely recognition of the need for more precise work on certain nuclear reactions important to the long-term development of atomic reactors. The reactions are the ones involved in the fast breeder and fusion reactor programmes and in the processing of radioactive waste.

The nuclear industry world-wide had believed—until recently—that existing nuclear measurements were enough to design new reactors; but nuclear physicists have now convinced the industry that many neutron-nucleus interactions are known so imprecisely that even quantities as crucial as the critical mass of a fast breeder reactor core are still uncertain. And the details of the build-up of many dangerous radioactive species in fast breeder and fusion reactors are still unknown.

The new, 26-m-long machine planned by Harwell will replace a 20-year-old 45-MeV accelerator which has been working flat out, 24 hours a day, for the last 13 years of its life. The new accelerator's 140-MeV energy and six times greater intensity will allow division of its beam to a number of experiments simultaneously.

It will also allow generation of 10 times more fission neutrons in Harwell's unique "neutron booster"—a subcritical mass of ^{235}U. Here brief but powerful pulses of electrons from the accelerator generate bursts of fission neutrons from the uranium. The neutrons are then energy analysed by measuring the time each reacting neutron takes to travel down an evacuated flight tube. The improvement in intensity will enable Harwell physicists to measure many reactions to considerably greater precision than hitherto, and allow them to investigate yet other reactions that were unmeasurably smothered in the inevitable instrumental "noise".

Dr Eric Lynn, who will direct the programme of research on the new accelerator, intends to use the facility for measurements to about ½ per cent error (present errors are 3 per cent) on neutron reactions at different energies with plutonium and uranium (for the reactor core), with iron, chromium, nickel and sodium (for the structure and cooling of the reactor), and with exotic control-rod elements such as the Ranthanide, europium.

One problem of particular importance will be the measurement of "fission structure groups"—ranges of neutron energy to which certain fissile nuclei are particularly sensitive The unexpected discovery of such groups in plutonium fission 10 years ago was responsible for a complete change in choice of fast breeder core material from plutonium oxide to plutonium carbide.

Electronic eye sees cosmological redshifts

The latest weapon to defend the view that the redshifts of galaxies are truly cosmological is a Spectracon image converter, developed at Imperial College by Professor J. D. McGee. This device is particularly suited to the detection of faint bridges connecting galaxies. One argument against the cosmological hypothesis, is the observation that apparently close pairs of galaxies sometimes have very different recession velocities. According to Halton Arp some pairs are joined by luminous threads of matter. If any physical connection could be shown to exist between two galaxies with greatly different redshifts the traditional interpretation of galactic redshifts would be shot to pieces. Confirmation, or otherwise, of Arp's intergalactic filaments is therefore a matter of some importance.

The Spectracon has a higher quantum-efficiency than a photographic plate. Light releases electrons from a photocathode; the photoelectrons are then focused to form an image in nuclear emulsion. The technique gives high resolution, a large storage capacity for optical information, and a linear response. These features combine to make the device superior to photography in the investigation of faint features.

Merle Walker, C. D. Pike, and professor McGee recently examined three groups of galaxies with Spectracon image converters mounted on the three-metre reflecting telescope at the Lick Observatory. (Astro-physical Journal, vol 194, p L125.) One couple which they probed was the close pair Markarian 205 and NGC 4319. Although these have different velocities, Arp claims they are physically related, and he has taken photographs showing a luminous connection. However, the Spectracon users found no trace whatsoever of this bridge, even though they found unrelated features considerably fainter than Arp alleged the link to be

Seyfert's Sextet is a tight clump of objects with one galaxy travelling 15 000 km/s too fast. But the Spectracon could find no connection between this fast galaxy and the other five. Presumably the cluster is, in fact, a stable quintet seen in projection against a more distant galaxy. Finally, another pair backed by Arp, namely NGC 7603 and its companion, failed to register any sign of interaction. They too are presumably unrelated objects.

The attackers of the cosmological explanation of redshifts have always set great store by the luminous filaments. The Spectracon results have seriously weakened the case against cosmological redshifts.

Do legumes switch on their nitrogen fixers?

If the inability of most major crop plants to fix their own atmospheric nitrogen could be overcome, more people could be fed for less money—on high-yielding crops that would otherwise consume prohibitive quantities of nitrogen fertiliser. Hence the interest in the mechanics of the exclusive partnership of leguminous plants with a useful little bacterium which can fix nitrogen, but only in intimate association with its plant host, which then benefits from its activities.

Recent research on these bacterial symbionts, the rhizobia, has answered two important questions. First, what is it that prevents the bacteria from associating with non-legumes?—And second, what role does the plant play in the process of nitrogen fixation, and is it something only legumes can do?

There was a minor breakthrough two years ago when M. J. Trinick managed to get a rhizobium species to associate with a non-leguminous plant. Now J. J. Child of the National Resarch Council of Canada, and W. R. Scowcroft and A. H. Gibson of the CSIRO in Australia have followed on with more detailed investigations which seem to show that once the initial reluctance of rhizobia to have anything to do with non-legumes has been overriden, the partnership works quite well. They have also discovered a factor or factors, yet to be identified, that seems to represent the plant's contribution to the symbiotic fixation of dinitrogen (Nature, vol 253, pp 350 and 351).

Both groups established nitrogen-fixing plant callus-rhizobium cultures on a membrane over the agar dish on which the bacterial culture was growing. This enabled them to lift off the plant culture leaving some of the associated bacteria behind. These bacteria continued to fix nitrogen for some hours after the removal of the plant tissue. This phenomenon enabled the researchers to conclude that the plant cells must be providing a diffusible substance essential for the nitrogen-fixing activities of the bacteria.

Since it is already known that the bacteria themselves possess the gene for the essential nitrogen-fixing enzyme, nitrogenase, these results imply that the plant cells provide some chemical trigger without which the gene cannot be switched on. They also indirectly imply that the failure of rhizobia to associate with non-legumes probably lies in the mechanism of infection.

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Why Jupiter spits out fast electrons

A month before Pioneer 10 reached the vicinity of Jupiter its particle detectors registered an unexpected phenomenon: the planet emits bursts of relativistic electrons with energies of up to 30 MeV. The bursts may last up to two days but analysis of their spectra reveals a 10-hour periodicity in keeping with the Jovian rotation period. This puzzling discovery was confirmed a year later by Pioneer 11 which also recorded proton bursts at up to 100 million miles from Jupiter. Three astrophysicists from Rice University, Houston, Texas, now provide a simple explanation for these synchronous particle bursts. On Jupiter's night side, where the containing pressure of the solar wind is reduced, energetic particles in the belts of trapped radiation surrounding the planet may just fly off tangentially in response to centrifugal effects caused by Jupiter's rotation (Geophysical Research Letters, vol 1, p 333).

The model which T. W. Hill, J. F. Carbary, and A. J. Dessler present, however, requires one other feature. If the release of particles were simply determined by Jupiter's rotation there should be a steady stream of electrons, not a series of bursts, emitted. To achieve the latter calls for some asymmetry in either the source of the plasma surrounding the planet, or the Jovian magnetic field. Such lopsidedness is not impossible to conceive as Jupiter is well known to possess a number of asymmetries: its magnetic field is 11° skew to its axis; the Great Red Spot has no exact symmetrical counterpart in its opposite hemisphere; and the Jovian decametric radio emission occurs in bursts related to some longitudinal asymmetry.

The three Rice University workers point out that since at least half the energy for Jupiter's atmosphere comes from internal sources, an irregularly distributed heat input could provide the necessary plasma source asymmetry.

Chicks and ducklings mum over toy trains

One of the features of an imprinting object is that its presence suppresses the distress peeping of a previously imprinted chick or duckling. In fact, with a moving object (which is more efficient as an imprinting stimulus than a still object) this suppression is almost immediate, which suggests that some innate mechanism is operating. The first presentation of a stationary object does not have an immediate suppressive effect on peeping, but after the bird has had some experience of the moving object the stationary object acquires the ability to suppress peeps. The current theory is that there are components of a stimulus, particularly movement, that innately elicit filial behaviour and that, by association, other aspects of the stimulus come to acquire the same property.

Can sounds suppress peeps? The mother hen or duck may make calls that innately elicit following in the young bird, but the sounds that accompany stimuli in the laboratory do not normally have this effect. In a recent paper in Animal Learning and Behaviour (vol 2, p 275) Leonard Eiserer and Howard Hoffman of Bryn Mawr, Pennsylvania, showed how sounds can be imprinted.

They used two groups of ducklings. They exposed one to both sight and sound of a model train engine, each day for five days. They exposed the other only to the sound of the train. After each exposure they presented the sound of the train alone, and measured the peep-suppression. As they expected the sound of the train gradually comes to suppress peeps only in the group that also saw the train.

This study is useful in that it emphasises the fact that imprinting is not a single mechanism. Innate responses to some aspects of the stimulus are involved, but so are learned responses. This perceptual learning ensures that the bird responds appropriately even when, for example, the stimulus is not moving.

Psis make a charming picture—or do they?

Wolfgang Panofsky, outgoing President of the American Physical Society, says that "there is no one interpretation which is even remotely convincing" to explain the new psi particles. Giving his retirement address last week Panofsky said that "the charm quark interpretation is the simplest and perhaps the least defective", but "it is likely that the correct answer will be . . . something else".

Not many physicists would put their doubts so strongly. While experimenters rush to make new measurements on the particle and its interactions, the theoretical consensus backs charm and hopes that the problems will resolve themselves. A few individuals like Professor Paul Matthews of Imperial College, London, prefer colour but on the whole charm sweeps all before it.

Meanwhile, an important theoretical paper in last week's Physical Review Letters (vol 33, p 236) adds some weight to the charm model and sharpens some of its predictions.

The theorists, S. Okubo, V. S. Mathur and S. Borchardt of the University of Rochester, New York, apply SU(4) symmetry breaking to the charm model. SU(4) is the "group theory" that describes in great detail the combinations of four quarks, just as SU(3) described three. If the symmetry were exact all the mesons would have the same mass, and it is necessary to introduce a very specific symmetry breaking process to account for the observed differences in mass between, say, the pion and the kaon. It was the symmetry breaking term in SU(3) assumed by Gell-Mann and Okubo (one of the authors of the present paper) that predicted so precisely the mass of the famous Ω^- particle back in 1964.

Now Okubo and his new colleagues have applied the same reasoning to SU(4), assuming that the psi at 3·1 GeV consists of a pair of charm quarks in the ground state. This gives a measure of the breaking of SU(4) and allows a precise prediction of the masses of other charm particles. The method is supplementary to and more far reaching than the Schrödinger equations approach described last week (New Scientist, vol 65, p 252) as it makes no detailed assumption about the form of the force between quarks.

For the lowest lying mesons with one charm quark Okubo and friends predict masses of 2·171 GeV (for the D^+, D° doublet—see New Scientist, vol 64, p 861) and 2·222 GeV (for the F^+). The particles will decay only weakly and so have very long lifetimes (of about 10^{-10} seconds). The researchers also catalogue the predicted masses of 25 other particles including charmed baryons, cousins of the proton and neutron containing one or more charm quark.

At the same time these workers make an important comment on the psi at 3·7 GeV (incidentally their reference to it is The New York Times—this subject is moving fast!) They point out that if the heavier psi is a radial excitation of the lightest one, it should fall into the same multiplet (or pattern) as better established radial excitations of other particles—in particular those of the rho and the kaon. Knowing these masses the theorists use their symmetry breaking formula to calculate the mass of the heavier psi. The result is 3·7 GeV, on target.

However an experimental paper in the same issue of Physical Review Letters (p 231) casts a little gloom on charm. The whole model assumes that the particles are strongly interacting—that they are hadrons. This implies that their interaction with other hadrons (such as protons and neutrons) is high. The "photoproduction" experiment reported in the paper, performed at low energy by a Cornell University team, shows the interaction to be less strong than expected. Although the Cornell experiment gives only an upper limit on the interaction, an experiment at Fermilab by a collaboration headed by Won Yon Lee at much higher energy is reliably reported within high energy physics circles to pinpoint the strength—or cross-section as it is called—of the interaction between the psi and a proton. The figure comes out at about 1 millibarn, roughly 40 times lower than the interaction between two protons. Optimists—and Won Yon Lee is one of them—say this is still strong enough for a hadron. A few are going to remain unconvinced.

Chemistry makes the primate world go round, too!

Springtime lambing, the elaborate courtship dance of the stickleback, the peacock's spectacular display and a host of other sexual activities are all controlled by hormones. In primates, like man and monkeys, it has been assumed that such influences had waned if not disappeared altogether, but it now seems that on the contrary, hormones influence a monkey's sexual behaviour to a large extent and both testosterone and oestrogen are necessary for the full reportoire of female activities.

At a recent winter school organised by the European Training Programme in Brain and Behaviour Research, Dr J. Herbert of the Anatomy Department, Cambridge University, described his progress in isolating different hormonal mechanisms which together influence mating in rhesus monkeys.

Predictably enough, he found that attractiveness and receptivity were not synonymous and each is controlled by a different hormone. Receptivity or the female's willingness to mate, although naturally influenced by how attractive or dominant the male appears, is governed by testosterone produced mainly by the adrenals but also to a lesser extent by the ovaries. Deprived of adrenals and ovaries she is totally unreceptive—issues no invitations and spurns his advances. Injections of testosterone, however, restore a female to normal, while extra testosterone steps up her sexual activities. Similarly, testosterone is reputed to increase the human equivalent — "libido" — in women although ovary removal has no effect.

Although the levels of testosterone fluctuate throughout the menstrual cycle, its continuous secretion ensures that monkeys and man are always receptive. Most non-primates, on the other hand, where the controlling influence is oestrogen, restrict their mating to a brief oestrous cycle.

When the levels of testosterone are highest — at ovulation time — the female monkeys are most receptive, but this falls off as progesterone produced during the last phase of the cycle inhibits testosterone secretion. Women too have claimed heightened senses at midcycle and just as progesterone diminishes receptivity in monkeys so the contraceptive pill, on account of its progestin, has been blamed for reduced sexual drive in some women.

Attractiveness, the other parameter of a female monkey's behaviour and measure of her seductive powers can, of course, influence the male's behaviour. Thus a female deprived of testosterone will issue no invitations and snub all the male's advances with the understandable result that his sexual ardour diminishes.

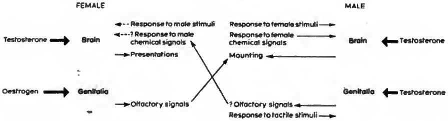
Changes in the female's oestrogen levels, however, have a more pronounced effect on the male's activities and he makes few overtures to an oestrogen deprived female, mainly because she no longer emits her usual alluring smell. Monkeys produce a collection of simple volatile fatty acids — "pheromones" — called copulins, whose vaginal secretion is controlled by oestrogen and whose function is to lure the male. The female's sexual activity parallels the levels of copulins, being highest at midpoint and falling off towards the end of the menstrual cycle—again due to progesterone secretion, which inhibits oestrogen as well as testosterone production.

Recently, Dr Michael and his colleagues in Atlanta found in women a similar range of fatty acids showing the same cyclic variation in concentration as the copulins (Science, vol 186, p 1217). But here their function is unknown; it seems unlikely that they act as overt sex attractants in western women.

The classic menage a trois situation demonstrates how one monkey's behaviour can dramatically alter another's. When the favourite was given progesterone to make her less attractive the male transferred his attentions to the second; her increased willingness to mate could only be the result of changes in the others' behaviour towards her.

Evidence from male monkeys showed that behaviour can actually alter hormone levels—sexual stimuli increase, while the stresses of fear or male dominance diminish, testosterone levels (men suffer similar effects from fear and anxiety). Cats, ferrets and rabbits furnish the best example, where copulation or even the sight of a male causes ovulation.

Dr Herbert stressed the importance of androgens in primate sexual behaviour and how different this was from the situation in non-primates. Although both hormones controlling female receptivity act in the same area of the brain—anterior hypothalamus; and the same chemistry is probably involved—a serotonin containing neural system—the key in primates is testosterone, as against oestrogen in non-primates. Differences also exist prenatally. Whereas in rats androgen treatment produces masculinisation which affects the offspring's pituitary and behaviour, baby girls similarly exposed, if treated early enough, develop normal feminine patterns of ovulation and behaviour.



In the female, testosterone acts on the brain causing changes in behaviour (presentation), while oestrogen acts on the genitalia increasing the secretion of copulins which then affect the male's behaviour. In the male, testosterone affects brain and genitalia, and directly influences behaviour. The hormone may also change some signals transmitted to the female.

How a baby learns to live in an adult world

According to Piaget, whose theories it has recently become fashionable to re-examine, the world of an infant for the first year is an egocentric place. Not so, says M. Scaife, working with Jerome Bruner in Oxford. Babies can begin to interact in a quite complex way with other people even at the age of two months.

Scaife and Bruner were looking at the tendency of small babies to follow the direction of gaze of their mothers and other adults (Nature, vol 253, p 265). In following someone else's gaze, the child is, in a sense, putting himself in someone else's world—he is not simply looking at another person, but looking at what someone else is looking at. Clearly this behaviour could play a large part in the cognitive and social development of the child. In fact, gaze-following may well have a respectable evolutionary history: Scaife and Bruner quote the example of hartebeestes, which, when one of their number signals danger, raise their heads and turn in the direction in which the signaller is pointing.

To show that this useful ability develops early in human babies, Scaife and Bruner collected 34 infants aged between two and 14 months. They placed each infant in a high chair in a small, sparsely-furnished room, with an experimenter who went through a prearranged sequence of head and eye movements while the infant was filmed through one-way glass on two video cameras.

Only about a third of the babies were following the experimenter's gaze at two to four months, but by eight to 10 months the number had risen to two-thirds; while all babies over 11 months showed unequivocal evidence of what Scaife and Bruner describe as "joint visual attention."

All in all, the results of these experiments go to show that there is more going on in babies' heads than experimental psychologists had supposed—and not all of it conforms to the theories of Jean Piaget.

Vitamin A may inhibit cancer: but it's toxic

Up till now, most workers in cancer research have concentrated on finding ways of destroying overt tumours. A somewhat smaller, though still considerable, group of researchers have directed their efforts toward prophylactic tactics: preventing contact between potential carcinogens and susceptible tissues. But as yet no-one has looked at the possibilities for therapy during the interval between a cell's exposure to a carcinogen and that cell's transformation into a malignant one—often a period of 20 years or more.

Now some new research, reported in Science (vol 186, p 1198) and presented recently at a workshop on vitamin A (retinol) in Bethesda, suggests there is good evidence that this micronutrient plays a part in hindering the development of an at-risk cell into a malignant one, and aiding a return to health.

Since one of vitamin A's roles is in the differentiation of epithelial tissues into specialised ones, it comes as no surprise that it could have some role in epthelial tumour development—which normally involves a loss of differentiation.

It appears that animals who have long-term vitamin A deficiency are much more cancer prone. Michael Sporn and David Kaufman (National Cancer Institute) find that carcinogens of various types bind much more firmly to DNA from cultured tracheas of vitamin A deficient hamsters than that of healthy counterparts. And Paul Newberne and Adrianne Rogers (Massachusetts Institute of Technology) discovered a higher incidence of colon tumours, caused by the carcinogen aflatoxin B_1, in rats deficient in vitamin A than in controls. Taken with the claim by Barbara Underwood (Pennsylvania State University) that 30 per cent of the population have low concentrations of vitamin A in their liver, these results, although still preliminary, are of no little import.

Moreover extra retinol given to healthy animals can exert a cancer-protective effect. Various researchers, working with different species and different carcinogens have all come up with the same conclusion: that retinol or its derivatives can inhibit carcinogens acting on at-risk tissues. And in certain cases they can even have a beneficial effect on already malignant cells.

A word of caution however. It would be all too easy on the basis of these results to set off a new nutritional fad—like those associated with vitamin E and the still controversial vitamin C. And the tremendous danger is that unlike the other two, vitamin A is very toxic in doses only slightly higher than the daily requirement. Much work is being done now to find suitable retinol analogues that don't carry the unwanted side effects.

Are we but worms writ large?

A major uncertainty in the descent of man occurs at the time, perhaps in the Silurian epoch some 400 million years ago or even earlier, when the first vertebrates emerged. But—and this is the big question—from what group of invertebrates did they, and eventually ourselves, arise? Many suggestions have been made. But Professor E. N. Willmer of Cambridge University now re-opens the possibility, first put forward by a Dutch embryologist, A. A. W. Hubrecht in 1883, that an obscure group of worm-like creatures called Nemertines (which the late Professor Pantin once described as "the only worms which sneer at you") provide the "missing link" here. (Biological Reviews, vol 49, p 321).

The first animals were undoubtedly single-celled, and would have had no difficulty in floating in surface waters. However, the larger multicellular organisms into which they somehow evolved would have tended to sink to the bottom. There would have been plenty of food there, but also many organisms competing for it. Thus any creatures cunning enough to evolve the ability to swim would have been able to turn to account a whole new zone, the mid waters, in much the same way as insects and birds later capitalised on the air by evolving flight. This opening, Professor Willmer suggests, was exploited by some of the early Nemertines. Some of these worms, he feels, had the right mixture of potentially vertebrate characters, but, since they evolved into vertebrates, they no longer exist now. Being small and soft, they would be most unlikely to have left any fossils.

The main advantage of this new skill, swimming, would have been to enable these animals to find new types and sources of food, probably by filter-feeding using structures which later became the typical vertebrate gill-slits. Then the characteristic Nemertine proboscis, used by some present-day forms to catch food, could have provided the basis for the semi-rigid notochord which would be necessary for efficient oscillatory swimming movements, and which eventually became the typical vertebrate backbone. Improved swimming would also have necessitated the development of better sense organs, both internal proprioceptors and distance receptors, together with coordination of the information they provided, and adequate control of the musculature. A complex central nervous system would therefore have soon developed, as would many other structures nowadays associated with vertebrates. For most of these, like the lateral line, the pituitary, the liver etc, Professor Willmer can find plausible precursors in present-day Nemertines, though in some cases he admits that the evidence remains equivocal.

Professor Willmer does not claim that this idea of the Nemertines " . . . an apparently insignificant, highly specialised and superficially rather aberrant group" being the ancestors of vertebrates is, as yet, more than a plausible hypothesis. Further investigations of this group of animals, especially in such areas as the composition of their proteins and the secretions of various organs, may help to establish the truth or otherwise of this extremely interesting, if rather humbling, hypothesis about our early origins.

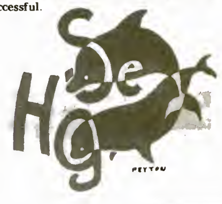
Mercury matches selenium in seals and dolphins

Seals and dolphins from many parts of the world show a straight-line one-to-one correlation between accumulation of mercury and of selenium, suggesting that selenium is involved in a detoxification mechanism for mercury. J. H. Koeman of the Agricultural University, Wageningen, Netherlands, and colleagues (The Science of the Total Environment, vol 3, p 279), examined 56 marine mammals of nine different species. Most were common seals (Phoca vitulina) from the North Sea; but the sample included other seals, porpoises and dolphins from the north Atlantic, Baltic and Caribbean; dolphins from New Zealand; and (somewhat inexplicably) three captive bottle-nosed dolphins from a Dutch dolphinarium.

Absolute liver and brain levels of mercury and selenium varied by two or three orders of magnitude, but produced a straight-line correlation expressible as $\mathrm{Hg} = 2{\cdot}53\,\mathrm{Se} + 10{\cdot}2$ (in parts per million), with a 0·991 correlation coefficient. Since the atomic weight ratio between mercury and selenium is 2·54, this relationship indicates that after an initial accumulation of mercury, any additional up-take of mercury and selenium is on an atom for atom basis.

Similar analysis of the fish on which these marine mammals feed does not reveal a one-to-one relationship between mercury and selenium; instead, the selenium levels are about 40 times those of mercury: a 16:1 atomic ratio. This implies that the one-to-one ratio is metabolically established in the marine mammals.

It is known from laboratory experiments that selenium compounds have a protective effect against the toxic action of mercury. Moreover, organoselenium compounds such as the amino-acid analogues selenocystine and selenomethionine can be synthesised in mammals. While it is tempting to suggest that selenium is used by marine mammals to lock up and thus detoxify mercury ingested in their food, there is still no direct evidence that this mechanism is successful.



The quest for Gaia

Do the Earth's living matter, air, oceans and land surface form part of a giant system which could be seen as a single organism? Could man's activities reduce such a system's options so that it is no longer able to exert sufficient control to stay viable?

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is at Bowerchalke, near Salisbury, and
Dr Sidney Epton
is at Shell's Thornton Research Centre

Consider the following propositions:

1. Life exists only because material conditions on Earth happen to be just right for its existence;
2. Life defines the material conditions needed for its survival and makes sure that they stay there.

The first of these is the conventional wisdom. It implies that life has stood poised like a needle on its point for over 3500 million years. If the temperature or humidity or salinity or acidity or any one of a number of other variables had strayed outside a narrow range of values for any length of time, life would have been annihilated.

Proposition 2 is an unconventional view. It implies that living matter is not passive in the face of threats to its existence. It has found means, as it were, of driving the point of the needle into the table, of forcing conditions to stay within the permissible range. This article supports and develops this view.

The Sun, being a typical star of the main sequence, has evolved according to a standard and well-established pattern. A consequence of this is that during the Earth's existence the Sun's output of energy has increased substantially. The Earth now receives between 1·4 and 3·3 times more energy than it did just after its formation 4000 million years ago. The Earth's surface temperature at the time when life began has been calculated. These calculations take into account the solar input, the radiative properties of the surface and the composition of the atmosphere. At that time, the atmosphere probably contained ammonia and other complex molecules which acted like the glass in a greenhouse, that is, by reducing the radiation of heat and long-wave infra-red radiation from Earth. The calculations show that the surface temperature could indeed have been within the range we now know to be needed to start life off.

Once life began, it fed on the atmospheric blanket. Unless some means had existed for restoring to it heat-retaining gases such as ammonia, or of altering the Earth's surface to make it more heat-retentive, the planet would surely have become uniformly ice-bound and lifeless. The rate of increase of solar energy would have been too small to compensate. Yet the fossil record and the continuity of life gives no support to this conclusion. At the time of supposed emergence from glaciation, that is, when the radiation from the more active Sun had made up for the radiation loss due to loss of the heat-retaining gases, and when only the feeble beginnings of a new life should have been possible, complex multi-celled organisms had already evolved. Life must have found a way of keeping the temperature of the Earth's surface within the critical range of 15-30 °C for hundreds of millions of years in spite of drastic changes of atmospheric composition and a large increase in the mean solar flux. The calculations were wrong because they left out the effect of the defence mechanism that life uses to protect itself.

Extinction through glaciation was not the only danger. Overproduction of ammonia and other heat-retaining gases could have resulted in the opposite effect, known as the "runaway greenhouse", that is to a rapidly increasing surface temperature that would have scorched the Earth and left it permanently lifeless, as is the planet Venus now. The evidence that this did not happen is plain—we would not have written these words nor would you be reading them (Figure 1).

Has life been able to control other conditions of existence besides the surface temperature of the Earth? A most significant fact about the Earth is the composition of its atmosphere. Almost everything about its composition seems to violate the laws of chemistry. If chemical thermodynamics alone mattered, almost all the oxygen and most of the nitrogen in the atmosphere ought to have ended up in the sea combined as nitrate ion. The air we breathe cannot be a very fortunate once-off emanation from the rocks; it can only be an artefact maintained in a steady state far from chemical equilibrium by biological processes.

The significance of this was first realised some years ago when one of us, in association with Dian Hitchcock, took up the problem of deciding whether it would be possible to detect life on Mars by the use only of spectroscopic observations on its atmosphere. Our suggestion was to look for any combination of constituents that was far from chemical equilibrium; if such was found life might exist there. (So far no such combination has been detected on either Mars or Venus.)

Gaia

It appeared to us that the Earth's biosphere was able to control at least the temperature of the Earth's surface and the composition of the atmosphere. Prima facie, the atmosphere looked like a contrivance put together co-operatively by the totality of living systems to carry out certain necessary control functions. This led us to the formulation of the proposition that living matter, the air, the oceans, the land surface were parts of a giant system which was able to control temperature, the composition of the air and sea, the pH of the soil and so on so as to be optimum for survival of the biosphere. The system seemed to exhibit the behaviour of a single organism, even a living creature. One having such formidable powers deserved a name to match it; William Golding, the novelist, suggested Gaia—the name given by the ancient Greeks to their Earth goddess.

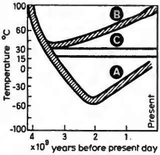

Figure 1 Possible and actual temperature history of the Earth's surface. *A*, Possible history if living matter had not produced enough heat-retaining gases, etc; *B*, possible history if living matter had over-produced heat-retaining gases (runaway greenhouse); *C*, actual temperature history

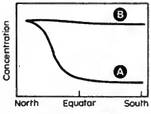

Figure 2 *A*, Expected change of concentration with latitude of man-made atmospheric pollutant generated in northern hemisphere (eg NW Europe). *B*, Actual distribution of carbon tetrachloride in the atmosphere

The past three years have been spent in exploring and elaborating the Gaia hypothesis (in collaboration with Lynn Margulis) and checking its implications against fact. It has proved to be fruitful. It has led us along many paths and by-paths, and valuable insights have been gained especially about the consequences of Man's interaction with the biosphere. The following is a selection of some of the interesting things we have found on the way.

Atmospheric constituents

If Gaia is a living entity we have the right to ask questions such as "what purpose does constituent X serve in the atmosphere?" As an example, the biosphere produces about 1000 million tons of ammonia a year. Why?

As already pointed out, in early times, when the Sun was cooler than it is now, ammonia served to keep the Earth warm. At the present time, the need for ammonia is different and just as important, because we believe that ammonia keeps the soil near to pH 8 which is an optimum value for living processes. It is needed because a consequence of having nitrogen and sulphur-containing substances in the air in the presence of a vast excess of oxygen is their tendency to combine to produce strongly acid materials—thunderstorms produce tons of nitric acid and if there were no regulator such as ammonia the soil would become sour and hostile to most organisms.

Another of our beliefs is that one of the purposes of the small but definite amount of methane in the atmosphere is to regulate the oxygen content. Methane is a product of anaerobic fermentation in soil and sea. Some of the methane rises into the stratosphere where it oxidises to carbon dioxide and water, so becoming the principal source of water vapour in the upper air. The water rises further into the ionosphere and is photolysed to oxygen and hydrogen. Oxygen descends and hydrogen escapes into space. In effect, methane production is a way of transporting hydrogen from the Earth's surface to the stratosphere in sufficient quantity to maintain oxygen concentration in the lower atmosphere.

We have also found interesting and unexpected trace gases in the atmosphere, such as dimethyl sulphide, methyl iodide and carbon tetrachloride. There is no doubt that the first two are biological emissions and they may well serve to transport the essential elements, sulphur and iodine, from the sea to the land. Carbon tetrachloride does not seem to have a biological source but its uniform distribution in the atmosphere, showing no difference between the Northern and Southern hemispheres, and other evidence suggest that it is not a man-made pollutant either. Its origins are an intriguing puzzle as is the question of its function, if any (Figure 2).

For more than 3500 million years in the face of a big increase of solar output, the mean temperature of the Earth's surface must have remained within the range of 15-30 °C. How did Gaia do this? She must have used several ways to keep surface temperatures so constant. Before there was a significant amount of oxygen in the air, the emission and absorption of ammonia by simple organisms may have been the control process, so making use of its heat absorbing and retaining properties. Variations of the concentration of ammonia in the air would therefore be a means of temperature control.

There must have been other ways as well, for the failure of only one year's crop of ammonia would have led to a self-accelerating temperature decline and extinction of life. One can envisage advantage being taken of the ability of certain algae to change colour from light to dark, thereby influencing the emissivity and the albedo of the surface. Later, when photosynthesising and respiring organisms existed and oxygen became a major constituent of the air, the control of the concentration of carbon dioxide, which is also a heat absorbing and retaining gas, may have been used to play a role in stabilising temperature.

Gaia and Man

Gaia is still a hypothesis. The facts and speculations in this article and others that we have assembled corroborate but do not prove her existence but, like all useful theories right or wrong, Gaia suggests new questions which may throw light on old ones. Let us ask another. What bearing has she on pollution, population and man's role in the living world?

Gaia has survived the most appalling of all atmospheric pollutants, namely oxygen, which was put into the atmosphere in substantial quantity about 2000 million years ago when the photosynthesisers had completed their task of oxidising the surface and the atmosphere. Whole ranges of species must have been killed off or driven into dark, oxygen-free prisons from which they have never been released; the appearance of the whole planetary surface and its chemistry were completely changed. To appreciate the impact of oxygen, think of what would happen to us if a marine organism began to photosynthesise chlorine and was successful enough to replace oxygen in the air with chlorine. This is science fiction, but oxygen was as poisonous to the primitive ferments as chlorine would be to us today.

Man's present activity as a polluter is trivial by comparison and he cannot thereby seriously change the present state of Gaia let alone hazard her existence. But there is an aspect of man's activities more disturbing than pollution. If one showed a control engineer the graph of the Earth's mean temperature against time over the past million years, he would no doubt remark that it represented the behaviour of a system in which serious instabilities could develop but which had never gone out of control. One of the laws of system control is that if a system is to maintain stability it must possess adequate variety of response, that is, have at least as many ways of countering outside disturbances as there are outside disturbances to act on it. What is to be feared is that man-the-farmer and man-the-engineer are reducing the total variety of response open to Gaia.

The growing human population of the Earth is leading us to use drastic measures to supply this population with resources, of which food has prime importance. Natural distribution of plants and animals are being changed, ecological systems destroyed and whole species altered or deleted. But any species or group of species in an ecological association may contribute just that response to an external threat that is needed to maintain the stability of Gaia. We therefore disturb and eliminate at our peril; long before the world population has grown so large that we consume the entire output from photosynthesisers, instabilities generated by lack of variety of response could intervene to put this level out of reach.

Puzzling climate

Are there any signs that we might have triggered something off already? There is at least one such possibility—the present puzzling climate. Unprecedented temperature decreases have occurred in northern regions, such as Iceland, along with many other unfamiliar manifestations, such as modified wind systems and rainfall distributions.

Many explanations of these climate trends have been put forward. Some mechanism that either reduces the amount of the Sun's radiation reaching the Earth or increases the amount radiated is required. Ecologists, not unexpectedly, place the blame on the products of man's activities. Increasing dustiness of the atmosphere, nuclear explosions, supersonic aircraft have all been proposed and considered, but within our admittedly limited theoretical understanding of what goes on, none has stood up well to criticism.

Another possibility which we are exploring is that one of the trace gas emissions such as that of nitrous oxide serves as a biological climate regulator. Nitrous oxide is produced naturally by soil micro-organisms at a rate of hundreds of millions of tons annually. The output varies however, as a result of agriculture, particularly from the use of nitrogenous fertilisers. We do not know how nitrous oxide could modify the climate, but the evidence suggests that it has been increasing in concentration and it is known to penetrate the stratosphere where its decomposition products could affect the ozone layer.

This climatic trend may be "just another fluctuation" of the kind which has occurred before and which will cure itself. This tends to be the meteorologists' views but the uncomfortable thought remains that none of the earlier occurrences has been explained. Perhaps some unidentified activity of man has been the common factor and nowadays there are a good deal more men about, active in many more ways. The consequences this time could well be much more serious and prolonged. We await developments somewhat uneasily.

Finally, a brief prospective look at the relation between man and Gaia, which also sums up the implications of this article. Socially organised man has the ability possessed by no other species to collect, store and process information and then to use it to manipulate the environment in a purposeful and anticipatory fashion. When our forebears became farmers they set themselves on a path, which we are still beating out, that must have had an impact on the rest of Gaia almost as revolutionary as that of the evolution of photosynthetic organisms millenia before. The area of the outside world that we, as a species, are capable of regulating to our short-term advantage has gradually expanded from the immediate locality of a settlement to vast geographical regions. This path could take us finally to the point at which the area of manipulation becomes the whole world. What happens then?

Nineteenth-century technocracy would say that we would then have won the final victory in the battle against nature. The Earth would be our spaceship, we the passengers and crew, the rest of nature, living and dead, our life-support system. But the price of victory might well be that we should have immobilised Gaia's control systems which she had established to keep the conditions on our planet at the level necessary for her and therefore our survival. The responsibility for the task of maintaining system stability would pass to us alone and it would be dauntingly difficult. As well as carrying technical burdens, we should also have to make agonising social and moral decisions, such as, how many passengers the spaceship could afford to carry and whom to throw overboard to make room.

A need to survive

The easier path is to rid ourselves of 19th century technocratic thinking, to reject the idea that human existence is necessarily a battle against nature. Let us make peace with Gaia on her terms and return to peaceful co-existence with our fellow creatures. Thirty thousand years ago some of our ancestors did something like this. They abandoned primitive hunting and took up what has been called the transhumane way of life. Men lived and migrated with the animal herds, defended them against other predators and systematically culled them for food. This ensured them a more plentiful and regular supply of animal products than the random hunting mode which it superseded. But our first priority as a species is to choose from the numerous technically feasible means of limiting our own population those which are socially acceptable in social and moral terms.

Now for one more speculation. We are sure that man needs Gaia but could Gaia do without man? In man, Gaia has the equivalent of a central nervous system and an awareness of herself and the rest of the Universe. Through man, she has a rudimentary capacity, capable of development, to anticipate and guard against threats to her existence. For example, man can command just about enough capacity to ward off a collision with a planetoid the size of Icarus. Can it then be that in the course of man's evolution within Gaia he has been acquiring the knowledge and skills necessary to ensure her survival?

Inventing Pandora's box

In some ways, Jim Lovelock—begetter of the Gaia hypothesis (see p 304)—is one of the last of the old-style natural philosophers. A scientist who works from his own home because he believes that lack of security encourages creativity, he has invented—among other things—"a magnificent Pandora's box", the electron capture detector gas chromatograph. Most sensitive of the analytical chemist's tools, it has been responsible for arousing concern about pesticide residues and Freons in the stratosphere, and may yet help to show that, thanks to Gaia, our fears of pollution-extermination are unfounded. Martin Sherwood visited him recently to talk about his work.

Few British scientists have a cloakroom wall decorated with three certificates of recognition from NASA "for the creative development of a scientific contribution which has been determined to be of signal value in the advancement of the aerospace technology programme of NASA". But then few British scientists work in a laboratory that used to be their garage, or an office that was once one of the children's bedrooms. Jim Lovelock does, because he believes that a secure job in an institutional setting can lead to atrophy of one's scientific creativity. For him, living by one's wits is a clearer sign of success than a comfortable Chair in any university. For more than a decade now, he has been working, mainly from his home a few miles outside Salisbury, on a variety of projects whose common factor is the use of chemical analytical techniques of the greatest sensitivity available.

His independent outlook perhaps has its roots in his reaction to the advice given to him by his headmaster at school. Science, he was told, was all right for amateurs, but it was not something one could make a living out of. Despite this advice, he went to university during the early part of the Second World War to study chemistry—had his mathematics been better, his subject would have been physics. Possibly the fact that he was then a "frustrated physicist" accounts for the emphasis on instrumentation in his work.

From his organic chemical beginnings, he developed an interest in the medical sciences. For nearly 20 years, he worked for the Medical Research Council, at the National Institute for Medical Research in London for most of this period, but for five years soon after the War at the Common Cold Research Unit at Salisbury. This move, made because the secondment to Salisbury offered extra money at a time when research scientists' salaries seemed to prove his old headmaster right, and he had a family to look after, was one of the factors that eventually led to his going "freelance". It showed him how much nicer Wiltshire is as a place to live and work compared to London.

His scientific research during the late 1940s and early 1950s was on topics such as aerial disinfection by substances vaporised at room temperature, and the effects of freezing on cells. The latter work included studies of the effects of substances such as glycerol and dimethyl sulphoxide in preventing haemolysis of blood cells during freezing.

The disintegration of blood cells as they freeze is caused by the salt concentration in the cell increasing as pure water freezes out: addition of chemicals such as glycerol, which can permeate the cell prior to freezing, can prevent this damage. Lovelock's work on this subject included similar studies on the reversible freezing of spermatozoa — an interest that was to play a role later in his life when he decided to become a freelance scientist.

Moving to chromatography

His present line of work started in the late 1950s, when he turned to problems in the then infant field of gas chromatography. Tony James (see "In search of order", New Scientist, vol 50, p 274) had joined the National Institute for Medical Research in 1951 and, in the following year, with Archer Martin, had discovered gas chromatography: a method for the separation of mixtures of very small quantities of volatile materials, based on differences in the rates at which they adsorb on a stationary material over which a stream of gas containing the mixture is passed.

The limitation of gas chromatography in its early years was not so much the degree of separation obtained, but satisfactory detection of the minute quantities of pure materials that were removed sequentially from the chromatographic column. Four years after the first published paper on gas chromatography, Lovelock began a collaboration with James on the gas chromatographic analysis of the fatty acids found in lipids from lipo-proteins and blood cells. For this work, no sufficiently sensitive detector was available. As Lovelock told an international symposium on gas chromatography in 1968: "It seemed that the best chance for developing a device with the sensitivity we needed would be to make some sort of ionisation detector. The first one I tried happened to be an 'electron capture' detector."

This was based on the electron affinity of different substances. At the end of the chromatographic column was an ion chamber in which free electrons were generated from the carrier gas. Compounds passing through the chamber in the effluent stream would affect the electron concentration, according to how strong an affinity they had for free electrons, and the changes in electron concentration could then be mapped as a series of chromatographic peaks.

Unexpected responses

Unfortunately, the first compound they tried ("a milligram of allegedly pure methyl caproate") produced 10 peaks on the chromatogram, none of which was attributable to methyl caproate (much less strongly electron absorbing than the impurities in the sample). "This unfortunate experiment, or should I say happening, was, to say the least, discouraging and we moved on to use the much more comprehensible argon detector . . . Nevertheless, whenever an opportunity arose I went back to play with the electron capture detector which was so splendidly nonconformist and such a magnificent Pandora's box of unexpected responses."

One such opportunity for re-exploring this Pandora's box came in the late 1950s, when Lovelock went to Yale University Medical School to collaborate with Seymour Lipsky—now professor of pharmacology there. Together, they published the first paper on the electron capture detector in 1960. As Lovelock told the 1968 international conference delegates, "I collaborated with Dr Lipsky in applying this detector to qualitative analysis; for this purpose it was, and still is, useful. However, to use it in qualitative analysis was hardly a tribute to one's faith in its ability to perform in quantitative analysis. Others were made of sterner stuff, however, and during this period Goodwin, Goulden and Reynolds were pressing the detector into service in that vital application which gave it the chance to prove itself, the analysis of pesticide residues."

In that last sentence, resides the importance (and to some extent the danger) of Lovelock's invention. With the possible exception of certain combined gas chromatography-mass spectrometry systems, the electron capture detector gas chromatograph is the most sensitive chemical analytical instrument ever designed. It moved chemical analysis from the parts per million range to parts per billion. In doing so, it has posed a problem. With detection now so refined, it is no longer possible to say that every "foreign substance" will interact with the environment in a significant manner.

This has come to the fore recently with the public interest in fluorinated hydrocarbons from aerosols disrupting the Earth's ozone layer (see "Aerosol sprays and the ozone shield" by Sherry Rowland, New Scientist, vol 64, p 717). This concern can be dated back to a paper which Lovelock published in Nature in 1971. In this he proposed that detection of the artificially produced Freons could be used to plot world weather patterns, and included data based on atmospheric sampling in southern Ireland.

After he had been a freelance scientist in Wiltshire for several years, Lovelock found that the extent of traffic from visiting scientists was so great that he needed a retreat. He bought a place in western Ireland to which he and his family could escape. However, the western Ireland establishment is now an automatic atmospheric monitoring station: although the Lovelocks managed to spend two months there last year, they did not get away from science.

In the long run, the Ireland monitoring station may prove important in the current Freon controversy, for Lovelock believes that he has now discovered natural halocarbon cycles which dwarf the importance of man-made halocarbons in disrupting the atmospheric balance. However, because of their different chemical structures, the compounds involved are less easy to detect by the electron capture method than the Freons. So no one had seriously looked for them until after the aerosol scare started.

In a sense, the halocarbon cycle is also a by-product of Lovelock's Gaia hypothesis, which he describes in this issue of New Scientist (p304). When I talked to him last month, Lovelock agreed that, in purely Popperian terms, it was difficult to see the Gaia hypothesis ever becoming a theory, because it was hard to see how it could be disproved. But, as he said then, "it has proved an extremely fruitful source of experimental suggestions". And a freelance scientist obviously needs a fountainhead for his day to day work.

From Houston to Salisbury

When he left NIMR in 1961, Lovelock went to a professorship of chemistry at Baylor University in Houston, Texas. It is possible that he was the first scientist in Houston to work on a NASA grant (before the Moon programme had been put forward). The family returned to Britain for a holiday each summer, and, in 1964, they returned permanently to an old cottage near Salisbury. After his five years at the Cold Research Unit, Jim Lovelock had found working in London again an unpleasant experience, and had hoped for an eventual return to Wiltshire.

How does a freelance scientist survive in an age of institutionalised science? Lovelock feels that he was lucky in that he came back at a time when Lord Rothschild was head of research for Shell. Because of his work on the freezing of spermatozoa, Rothschild had heard of him, and offered him a small retainer to act as a trouble-shooting consultant for Shell Research.

In addition to receiving money from Shell and other bodies for which he does research, he derives income from designing new instrumentation and selling prototypes to commercial companies. Like his NASA award work, most of this design is in the field of chromatography.

When I was with him, he was called away to the telephone to answer a call from California—where it was about 6 am—which he excused on the grounds that one could not afford to ignore business. However, such a concession is perhaps small by comparison with the advantages that he has in being a freelance.

His wife insists that he works far harder than he would need to do if he had a regular job; however, he obviously enjoys it. And he can spend whatever part of the day he likes to take his regular three to five mile walk. Much of my conversation with him took place on narrow roads, the chemistry interspersed with views of Cranborne Chase and a hedgerow which has recently been made a Nature Reserve because of its wealth of wild orchids.

There are disadvantages. From Houston, Lovelock had sent a number of papers to Nature, which had been accepted. The first that he sent from his home address was rejected—as the then editor of Nature told him when he asked why, they were always getting crank papers from people living in the country. He now holds an honorary professorship at the University of Reading, which means that he can give a "respectable" address at the end of each paper. Perhaps one heartening piece of evidence that, in Britain at least, one can still be a natural philosopher on one's own, without large-scale institutional backing, was the Royal Society's decision last year to make Lovelock a Fellow.

From an orthodox viewpoint, the existence of people like Jim Lovelock is possibly awkward. After all, if you have a chap doing science in his backyard (even if the family did have to give up aerosols two years ago because they interfered with the measurements), it could look bad when others in institutions ask the government for massive grants to do their science. And, as Lovelock says, there is always the possibility that, if you have a secure job, with no great pressures, you cease to be creative—and spend your time eking out old ideas rather than doing any more worthwhile research. (As an aside to those who have read Lovelock's article—how many other scientists, in their institutions, could quote anyone comparable to William Golding as having had a hand in suggesting a title for their hypothesis?)

Lovelock says that he cannot imagine himself working conventionally again. After so many years working for himself, although not by himself—without his wife to run the "business" he says it would not have been possible to cope—he tends to see his present condition as a natural one: "All you've got to do is find something that needs measuring and go and measure it."

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A new form of biological power

Biochemistry has a new word: proticity. The word was coined by Dr Peter Mitchell in a lecture he recently gave to the Biochemical Society to acknowledge his receipt of the 1973 Ciba medal. As an important aspect of biological energy systems, proticity could rapidly become as much a part of biochemical language as its counterpart electricity

Dr Robert Reid
and
Dr Henry Leese
are lecturers in the department of biology, the University of York

Peter Mitchell is something of a phenomenon in biochemical circles, not only because of his prodigious research output but also because much of this has emanated from a small laboratory at Bodmin in the depths of Cornwall, independently financed by a foundation committed to fundamental research and established by Mitchell and Dr Jennifer Moyle in 1964. There Mitchell, Moyle, a few able technicians and the occasional visiting research fellow have profoundly influenced thinking on one of the most important problems in biochemistry in a manner out of all proportion to their number and relatively small budget.

The Bodmin laboratory's success has, of course, not been achieved in isolation. There are lines of communication with larger research groups at the Universities of Amsterdam, Cornell, Marburg, Philadelphia and elsewhere, including Britain. Nevertheless, at a time of pessimism about the future of fundamental research in British Universities the Cornwall experiment shows what can be achieved by a few talented and compatible people in a "think tank" situation free from the internal politics and external pressures of the universities and larger institutes.

Mitchell is best known for his chemiosmotic hypothesis which attempts to explain how the high energy molecule ATP (adenosine triphosphate) is synthesised in living organisms. Although opinion is still divided on whether the hypothesis can provide a complete answer to the problem, it has been highly successful in suggesting meaningful experiments, and has led to a completely new way of thinking about membranes and energy transformation in biology involving proticity as a power transmitter. Characteristically, Mitchell is modest, dislikes pomposity and publicity, and is immersed in his work. Before moving to Cornwall he was a Reader at the University of Edinburgh. To say more about Mitchell the man would evoke a good natured retort on the telephone asking if we intended this article to be his obituary! So we will concentrate on proticity.

All systems that do work require energy. In plant and animal cells this comes mostly from the oxidation of carbohydrates and fats. However, in the same way as the oxidative combustion of coal could never turn the wheels of an old locomotive without the intermediacy of steam, it is hard to see how the energy-yielding oxidation of carbohydrate by living cells could drive many energy-requiring reactions of growth, division and maintenance without the intermediacy of some kind of chemical that acts as an energy carrier. ATP is just such a molecule. There are several ways in which ATP can drive reactions but these need not concern us. The real mystery is at the other end—how ATP is synthesised by the energy of oxidations.

Equation 1

$$\underset{\text{adenosine diphosphate}}{\text{ADP}} + \underset{\text{inorganic phosphate}}{\text{Pi}} + \text{energy} \longleftrightarrow \underset{\text{adenosine triposphate}}{\text{ATP}} + \underset{\text{water}}{H_2O}$$

The process itself—oxidative phosphorylation—occurs in cell organelles called mitochondria (see New Scientist, vol 64, p 551). Each of these "powerhouses" consists of an outer membrane separated by a space, the outer compartment, from an inner membrane thrown into numerous folds or cristae which enclose an inner matrix. The oxidative part of oxidative phosphorylation is an interesting piece of biological engineering. Typically an oxidation can be represented by the equation:

$$SH_2 + \tfrac{1}{2}O_2 \longrightarrow S + H_2O + \text{energy}$$

Where SH_2 is an oxidisable substrate, there is fairly direct transfer of hydrogen to oxygen, and the energy is released in one go. The mitochondrial situation is more complex. Instead of a single and potentially destructive release of energy, substrate oxidation takes place in small manageable stages, the energy being released little by little. This is accomplished through a series of carriers arranged in sequence as the electron transport chain and located in the inner mitochondrial membrane (Figure 1).

Each carrier in the sequence is a stronger oxidising agent than the previous one, oxygen being the strongest of all, so that hydrogen, can enter at the reducing end of the chain, be passed as protons (H^+) or electrons (e^-) from carrier to carrier, and emerge at the other end to combine with oxygen and form water. By using artificial electron donors and acceptors that interact at specific points of the chain, in conjunction with selective inhibitors, it has been shown that the energy released in this process is used to form ATP (Equation 1), that is, conserved at three regions in the chain. The question is how?

The first hypothesis, which dates from the early 1950s, followed classical chemical lines, proposing the existence of high energy intermediates that acted as go betweens, tapping the energy from the oxido-reduction reaction and transferring it to the phosphorylation reaction. This model could explain many features of oxidative phosphorylation. However, the postulated intermediates have not been isolated or identified, despite numerous attempts.

Then in 1961, Mitchell, working at Edinburgh, radicalised things by suggesting that the reason why the postulated intermediates were elusive might be because they did not

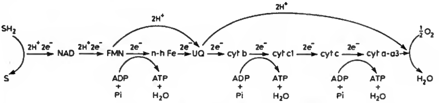

Figure 1 In the mitochondrial respiratory chain shown here NAD (nicotinamide adenine dinucleotide) transfers protons and electrons from substrate to the hydrogen carrier FMN (flavin mononucleotide). The electrons then pass through iron atoms (n-h Fe: non-heme iron) and combine with the protons to reduce the hydrogen carrier UQ (ubiquinone). The electrons then flow through the cytochrome chain and, together with the protons, reduce oxygen to water. Energy released during the electron transfer reactions is thought to be conserved as ATP in the three regions indicated

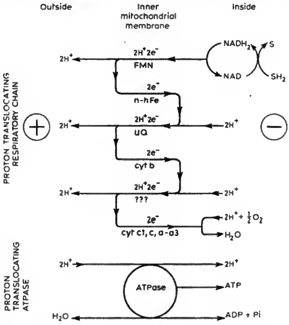

Figure 2 Top, one of several possible arrangements of the proton translocating respiratory chain to account for experimental findings. Note that the scheme requires alternation of hydrogen carriers with electron carriers. This particular model must assume an unidentified hydrogen carrier between cytochrome b and c1. Some workers think that UQ can operate on both sides of cytochrome b. Bottom, a "black box" representation of the ATPase driven by proticity

exist, and he proposed an alternative chemiosmotic hypothesis. Initially, this hypothesis arose from a study of the asymmetry of electron carriers in bacterial membranes rather than mitochondrial. In fact, one of us (Robert Reid) recalls Mitchell in front of a pH meter, saying "if the pH falls when I add this to Micrococcus lysodeikticus we will have champagne". It did, and since champagne was a cut above the usual celebratory cigar, we knew that something novel was under way.

From these experiments on bacteria, the idea was born that if the electron carriers were arranged vectorially (that is, in a fixed direction relative to one another, or more specifically in zig-zag fashion across the inner mitochondrial membrane) the energy of electron transport could be converted to an electrochemical gradient of protons across the membrane, and the gradient itself could be the elusive intermediate that drove ATP synthesis.

At first sight this might seem rather metaphysical but over the years the hypothesis has been formulated in quite precise physiochemical terms and experimental support has increased. It is now commonplace to talk about the proton-translocating electron transport chain, and there is some evidence that the carriers are organised in loops that translocate two protons out for every two electrons passing through. However, the details are far from clear. Figure 2 shows one possible scheme.

The carriers in the chain are mostly proteins with specific groups or metal ions that carry the reducing equivalents. With the exception of ubiquinone, which is soluble and diffusible in the lipid phase of the membrane, the carriers are thought to be relatively fixed but with enough mobility to permit interaction. Note too, that proton translocation leads both to a transmembrane chemical difference of protons and also an electrical potential difference since the protons are charged. The total energy, available —the electrochemical potential difference— is the sum of both components. Mitchell and Moyle have indirectly estimated this as at least 230 mV and probably more. It is difficult to estimate the exact amount of energy necessary to synthesise ATP under these conditions, but the indications are that there is quite enough energy inherent in the electrochemical potential difference to do this. But how?

For a start, clearly the 230 mV or more must be the force tending to suck the protons translocated out by electron transport back in again. It is proposed that the return flow of protons under the influence of this proton motive force (PMF) is directly coupled to ATP synthesis, catalysed by a membrane sited ATPase enzyme. As Figure 2 shows, two protons are thought to be translocated back for each ATP synthesised. Further, because under steady conditions, the same number of protons must be translocated in as out, the six protons pushed out by the energy of electron transport would be compensated by six moving in via the ATPase giving three ATP molecules. Happily this gives the classically accepted ratio of three ATP molecules per oxygen atom reduced (Figure 1). Significantly enough, if the membrane gradient is destroyed by adding any of a wide variety of reagents that increase membrane permeability to protons, oxidation goes on, but ATP synthesis is abolished: the protons simply short circuit through the leaky membrane without building up a potential great enough to drive the ATPase.

An obvious prediction of the hypothesis is that even when electron transport is completely inhibited, ATP synthesis should occur if a transmembrane gradient is artificially imposed that drives protons inwards through the ATPase. This has been conclusively demonstrated by experiments at Bodmin, here at York and elsewhere.

The elegance of the term proticity should now be clear. In the same way as electricity is the flow of electrons induced by an electromotive force, proticity is the flow of protons induced by a proton motive force. In the mitochondrion the PMF is generated by the proton translocating electron transport chain and the ensuing proticity drives the ATPase to synthesise ATP.

Proticity seems to drive photophosphorylation in chloroplasts as well as oxidative phosphorylation in mitochondria. When chloroplasts are illuminated, the energy of the photons increase the energy levels of electrons in chlorophyll molecules and these high energy electrons then pass along electron transport systems very similar to those in mitochondria losing energy as they go. As in mitochondria much of this energy is used to synthesise ATP. The electron carriers are present in the internal or thylakoid membranes of the chloroplast and electron transport creates a substantial *p*H difference across the membranes. In fact, values of 300 mV for the electrochemical potential difference have been estimated experimentally—even higher than that for mitochondria.

It has been shown mainly by André Jagendorf and coworkers at Cornell University that such *p*H gradients can drive ATP synthesis. So here again it looks as though the high energy intermediate that transmits the free energy available from light-driven electron transport into the chemical energy of ATP is a transmembrane PMF that powers a proticity-driven membrane ATPase.

It is impossible to say how many other energy-requiring biological systems are directly plugged into proticity. At least some bacterial species have membrane-sited electron carriers that generate transmembrane PMFs, and Alan Hamilton's group at Aberdeen University has shown that in some cases proticity can operate amino acid uptake from the media for nutrition. Mitchell and others have theorised on how proticity could be used for mechanical work such as bacterial locomotion.

There are still large gaps in our knowledge of all the systems under discussion. Nevertheless the evidence for membranes as energy transducers is now very strong and one feels that chemiosmotic principles are here to stay.

Probably when the dust settles something very like the Mitchell model will still be standing. In the meantime a recent experiment by Efraim Racker and Walther Stoeckenius at Cornell University illustrates the elegance of current approaches. A photosynthetic pigment from purple bacteria and an ATPase from heart mitochondria were incorporated into small membranous vesicles. Illumination resulted in electron transport in the pigment that generated a PMF that drove ATP synthesis. In effect, they had constructed a simple model that operated by proticity.

Possible practical applications? The last sentence of Mitchell's Ciba Lecture was cautiously optimistic, "The elucidation of the detailed mechanisms of the natural protonic devices may . . . provide intellectual nourishment and inspiration not only for the biochemist in search of knowledge but also for the technologist in search of inventions."

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Cosmic gamma-ray bursts

Transient phenomena are becoming a natural aspect of high-energy astrophysics. In recent months short bursts of gamma rays have been observed from a number of space platforms, leaving theorists perplexed—although not altogether tongue-tied—as to their origin

Dr Andrew Fabian
and
Dr James Pringle
work on X-ray astronomy at the Institute of Astronomy, Cambridge

The casual observer of the night sky will probably have the impression that most, if not all, celestial objects have a constant light output. Those that can be clearly seen to vary tend to belong to the solar system—for example, the Moon, planets, comets and such like. Further observation reveals variable stars that sometimes fluctuate in brightness on time scales as short as hours. Recently, surprising new phenomena, such as pulsars, binary X-ray sources, and cosmic gamma-ray bursts have been discovered in which large intensity fluctuations can occur in intervals much shorter than a second. From the time scale of the variability we can immediately deduce an upper limit to the size of such objects.

Suppose that the Sun is suddenly switched off. We on Earth, about eight light-minutes away, will see a dark spot appear in the centre of the Sun some eight minutes after switch off. The spot will then grow and engulf the whole Sun about two and a half seconds later. Although the switch-off occurred simultaneously at all points on the surface, the light from the visible rim of the Sun has to travel an extra solar radius (about two and a half light seconds) to reach us. Thus, in general, a large change in the intensity of a cosmic source of radiation cannot occur in an interval much less than the time light takes to cross the radiating region. The fluctuations observed in some pulsars which take place in a hundredth of a second, must originate in a Moon-sized region about 3000 km across. The emission regions associated with the abrupt changes we are discussing can only be much smaller than the Sun. As their luminosities often exceed that of the Sun by a factor of 10 000 or more, the phenomena we are dealing with are clearly not related to ordinary stars.

Thermodynamically speaking, the Sun is a fairly efficient radiator of energy; if it were to become more luminous it would have to be bigger or hotter or both. To get 10 000 times more luminosity from an area some 4000 times smaller, needs a temperature increase of a factor of about 2000; that is a temperature of about 10 million K. Electromagnetic radiation emitted by such a hot object comes off predominantly as X-rays and gamma rays with photon energies exceeding 1000 electron volts (the only alternative is for the object to employ some coherent emission mechanism or laser process such as produces the radio emission in pulsars). It is therefore not too surprising that it is the X- and gamma-ray astronomers who are discovering some of the most rapid phenomena in the cosmos.

The X-ray sources discovered so far are mostly detectable for periods long enough to give observers time to locate and study them in some detail, since either they display recurrent fluctuations (pulses) or some steady emission underlies the transient outbursts. (Exceptions are the X-ray "novae", which flare up for a few weeks or months and then disappear). In contrast, the cosmic gamma-ray bursts which have recently been detected last for only about ten seconds; they do not seem to recur nor do they have any steady components.

The gamma-ray bursts

As a consequence of the Partial Test Ban Treaty of 1963, which covered nuclear explosions in space, the United States launched five satellites of the Vela series to act as monitors. Each contains small omnidirectional detectors for the purpose of detecting gamma-rays from nuclear explosions. The detectors are inactive for most of the time, but are triggered by events exceeding about 10^{-6} ergs per sq. cm in a photon energy band of about 0·2 to 1·0 MeV. After triggering, the satellites record the events in some detail, in particular noting the precise time of occurrence. The relative times at which each satellite is triggered can be used (see below) to compute the position of the gamma-ray source. It was soon found that these positions were incompatible with a terrestrial origin.

R. W. Klebesadel, I. B. Strong and R. A. Olson of Los Alamos Scientific Laboratory announced the discovery of the first 16 cosmic gamma-ray bursts in 1973. Since then another eight or so have been reported, as well as other sightings of several bursts by detectors on OGO-3, IMP-6, OSO-7 and Apollo 16. This last system, in the Apollo 16 command module, was designed for determining lunar surface composition by fluorescence techniques. The burst the Apollo spectrometer detected is shown in Figure 1: a gradual 10-second onset and a 10-second decay phase are evident as well as the multiple spiked burst itself. Vela 6A responded to the same burst, being triggered by the second main spike, about 253 ms before it reached Apollo. The two detector systems were 232 000 km apart —a light travel time of 774 ms. From these figures (Figure 2) you can deduce by simple trigonometry that the line of sight to the source of the burst makes an angle of about 71° to the line joining the two detectors. This defines a band in the sky, whose width is determined by timing errors, within which the source must lie. Further work, using the pointing directionality of the detectors and the observed intensities, narrowed the source location down to a region about 15° across centred in the constellation of Indus. That is about 50° away from the plane of the Milky Way and close to the Small Magellanic Cloud. The disc of the Sun or Moon is about half a degree across, so that, as the reader may imagine, the number of objects within a 15°

circle which could be the source of the gamma-ray burst is rather large.

Some of the earlier bursts were detected by three or more of the Vela satellites. A similar method of triangulation allowed one or more source positions to be established, though none with anything like sufficient accuracy to offer hope of the identification of the origin of the bursts with known objects. Astronomers could, however, show that the sources of those bursts were at least as far away as the edge of the solar system and probably much more distant. The total energy emitted by the sources must be about 10^{33} ergs multiplied by the square of the distance to the source in parsecs (the Sun emits 4 x 10^{33} ergs per second). The energy spectrum of the events can be traced from X-rays of 5 keV up to gamma rays of several MeV. The overall spectrum is uncertain, but it is compatible with that expected from an optically thin gas at a temperature of about 1000 million K. At present the rate at which bursts are seen is about four per year, although with future more sensitive detectors this number will almost certainly increase.

Extravagant speculation

Because of the relative lack of data at present, theorists are not too tied by observational constraints and so have put forward a large number of ideas for the production of these bursts. They may, of course, all be right but it is just as likely on present evidence that they are all wrong. The reader may wish to decide which proposal he finds the most credible or agreeable. There is as yet no clear evidence for anisotropy (non-uniform distribution) of the directions from which the bursts originate. Objects close by in our own Galaxy—for example the brightest stars—are distributed fairly symmetrically around the sky, as are the more distant objects we know (distant galaxies, quasars etc) indicating that the universe is isotropic and that the Earth is not at any special point in space. On the other hand, objects intermediate in distance (the local group of galaxies or most of the stars in our own Galaxy) are distributed in a highly anisotropic manner—for example the faint stars in the disk of our Galaxy form a ring around the sky known as the Milky Way. It is therefore usual to assume that the origin of the bursts is either distant and extragalactic or close by in our own Galaxy.

Ideas for extragalactic sources include the early stages of radio outbursts in quasars, and shock waves in supernovae. Quasars are the most distant and the most luminous objects that we know. They are seen as radio sources which coincide with faint fuzzy optical objects whose spectra indicate that they are receding from us at speeds close to that of light. To produce an outburst in the radio flux from such an object requires a large number of relativistic electrons. Such a cloud of electrons may well have been produced in a relatively small volume before it expanded and cooled to produce the radio emission. In its early stages, the cloud may have contained electrons with such high speeds that they could scatter the universal background radiation which is at 3 K (this was hotter in the past and is the remnant of the fireball of the Big-Bang which gave birth to the universe) to produce the required gamma rays.

Supernovae occur in most known galaxies —usually at the rate of about one every 30 years. They signify the violent death of a star and the scattering of the star's burnt nuclear fuel back into the interstellar gas. Often, if not always, the compressed core of the original star remains behind as a neutron star which can be seen by radio astronomers as a pulsar. It is interesting to note in passing that most objects around us on Earth are made of this burnt nuclear fuel and that, without supernovae, life as we know it would not exist. The supernovae can start when a star runs out of nuclear fuel and so its central regions can no longer hold themselves up against gravity. The centre of the star collapses and the energy released in the collapse is transmitted outwards by a shockwave and explodes the star. When the shockwave reaches the outermost, and least dense, parts of the star's atmosphere the shock energy is spread among fewer and fewer particles. The energy given to each particle grows indefinitely and gamma rays could be produced in a sudden burst.

Such a gamma-ray flash was predicted some years before the discovery of the Vela bursts. Unfortunately, recent theoretical calculations indicate that the flash should last for only about 10 μs rather than the observed 10 s or so. When this millionfold discrepancy is compounded with the lack of optically observed supernovae near the locations of the bursts, even the most optimistic astronomer has to back down.

A number of the exponents of theories involving nearby sources favour neutron stars both to produce the energy needed and to account for the short time scale. Old neutron stars are thought to be quite common in the

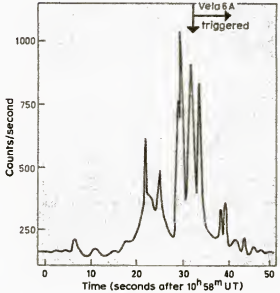


Figure 1 Gamma-ray burst of 27 April 1972 observed with the gamma-ray spectrometer aboard Apollo 16

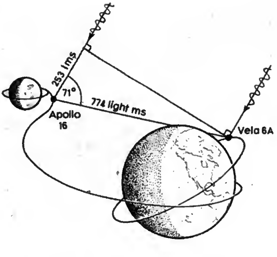


Figure 2 The second peak of the gamma-ray burst depicted in Figure 1 was detected by the satellite Vela 6A 253 ms before Apollo 16. The geometry of the situation shows that the origin of the burst lay somewhere in the band of sky 71° from the line joining the detectors

Galaxy and there are two basic means of extracting the required energy from them. First, a blob of material falling onto a neutron star gets up to a speed of about a half the velocity of light (see X-rays from close binary stars, by the present authors, New Scientist vol 61, p 343) and therefore dissipates a sizeable proportion of its own rest-mass energy on striking the stellar surface. If the blob is massive enough, the energy released is radiated as gamma rays. Suggestions of where such blobs of matter can come from include gas thrown out by giant prominences from the surface of a companion star, and even comets which might smash into the neutron star's surface. Second, as a neutron star forms, parts of it crystallise. Subsidence may later take place resulting in fracturing of the crystal structure and violent starquakes. The energy released in such a starquake could easily account for that of the gamma-ray bursts, but the problem is to induce it to come out in the form of gamma rays. One suggestion is that the shock waves produced by a 'quake could dissipate their energy close to the surface, heating it temporarily to high enough temperatures to produce gamma rays. Other theorists make use of the fact that most observed neutron stars have a strong magnetic field. The starquakes cause the surface of the star to oscillate, twanging the magnetic field lines attached to the surface. These magnetic field lines usually have a host of particles attached to them which are then accelerated to high energy and even released. Again such high-energy particles could produce the required burst of gamma rays, rather like a scaled-up solar flare.

Solar flares are the result of the magnetic field in the Sun being twisted up by convective motions and suddenly unwinding and dissipating its energy in the form of fast particles, which can then produce X- and gamma rays. A number of stars have magnetic fields that are several thousand times as strong as that of the Sun. It is possible that such stars could give rise to "superflares", similar to those of the Sun but much more powerful. The time structure of such events could mimic that of the observed bursts quite well.

The same is true of yet another hypothesis —collisions between chunks of antimatter and stars. When ordinary matter and antimatter meet, they annihilate to produce gamma rays; an initial sharp flash as the chunk enters the star could be followed by a longer burst as the bubble of reacting antimatter rises back to the surface.

Even closer to home, is the suggestion that pulsars can emit relativistic dust grains, possibly during a glitch (irregularity) in the pulse period. Such a grain approaching the Sun would see the Sun's rays blueshifted to such an extent that they would appear as gamma rays to it! The grain would immediately disintegrate and, in doing so, emit photons which we, in turn, would see as a shower of gamma rays. The existence of such fast grains has yet to be established, however.

Recent calculations on quantum effects in the neighbourhood of a black hole suggest that a black hole can evaporate. Theoretically, the rate of evaporation, and the temperature of radiation released, increase very rapidly as the black hole loses mass and shrinks. If a black hole started small enough it could evaporate completely yielding a sudden burst of gamma rays as it did so. Perhaps such explosions of mini-black holes could be the origin of the mysterious gamma-ray bursts. We really have no good idea of how many mini-black holes there could be around as they are almost impossible to detect otherwise. They would have been formed in the very early stages of the birth of the universe.

An ominous interpretation

Some of these ideas may seem a bit far fetched (some of them probably are!) but let us consider something even less likely—we hope. Suppose that throughout the Galaxy there are many civilisations similar to that on Earth. Suppose, too, that a fraction of them, in the gaining of knowledge about atomic weapons and the subsequent power struggle, manage to destroy themselves in a nuclear holocaust. Such an event would register as a powerful burst of gamma rays from precisely the same kind of source as the Vela satellites were originally intended to discover! Let us hope that we manage to avoid a similar fate.

As the reader may have noticed, the theory-to-event ratio for the cosmic gamma-ray bursts is rather close to unity, indicating that the theory is in a rather bad state. As time proceeds and more events are detected, we anticipate that more constraints will be made on theoretical explanations and that some of the above suggestions can be discounted. Let us at least hope that the rate of discovery of new bursts exceeds the rate of production of new theories.

Technology review

US company says landing system decision rigged

Whitehall's hopes of persuading the Americans to adopt the British doppler system for their next generation of airport landing aids seem to have backfired badly. And in the process an all holy row has broken out in Washington with bitter cries of "Watergate" and "sell out".

One of the two American companies working on doppler MLS (microwave landing system) has even slapped an injunction on the Federal Aviation Agency (FAA) for alleged rigging of the voting—which resulted in the recommendation that the US should adopt the scanning-beam type of MLS instead of the expected doppler version developed by Standard Telephone Laboratories at Harlow. Which ever microwave landing system the FAA finally chooses as the US national system will then be submitted to the International Civil Aviation Organisation (ICAO) as the US proposal for a standard world-wide MLS system. America demonstrably has enough political muscle at ICAO to flatten any other competing proposal no matter how good technically—including proposals from France, West Germany and Britain.

Representatives of the UK Civil Aviation Authority and Plessey (which has the prime contract for developing doppler MLS in Britain) flew to Washington a fortnight ago to contest the FAA central assessment group's "procedural irregularities" with a higher level executive committee—pointing out that, despite the central assessment group's last minute change of rules when scanning-beam had effectively lost the contest, doppler is still the safer and more reliable system, and is also cheaper to build and operate than scanning-beam. But above all, they say, doppler MLS has been fully evaluated; the scanning-beam system chosen has yet to be tested—having been hurriedly resubmitted after the two original scanning-beam systems lost out in the FAA's own "fly-off" trials.

The scanning-beam version of MLS is essentially a "lighthouse" with a rotating radar beam which is switched on as it sweeps across a particular sector of its scan. Doppler, by contrast, is a means for automatically and continuously encoding each point in a large wedge of radio space with its own polar coordinates relative to the runway. Where scanning-beam provides the pilot with a torch for seeing in the dark, doppler illuminates the the whole area so he can see all the time automatically. Moreover, like FM radio, the frequency modulated doppler beam is not subject to the interference that affects the amplitude modulated scanning-beam (New Scientist, vol 62, p 747).

Satisfied that doppler had more inherent advantages than alternative systems, several years ago the British government concentrated all its development work on a civil MLS system based on doppler. A £1 million joint contract was shared between Plessey and STL. To help the Americans also choose doppler, the Civil Aviation Authority (CAA) agreed to give all its doppler blind landing know-how to the FAA, and two British firms signed collaboration agreements with ITT Gilfillan and Haseltine, the two US companies developing doppler MLS in competition with scanning-beam proposals from Texas Instruments and Bendix.

The first signs that all was not well between the two aviation authorities came late last autumn. Seeing the prize slip from its grasp on technical grounds, the scanning-beam lobby in the FAA got the central assessment group to accept a time reference version in place of the frequency based scanning-beam. Theoretical estimations of its performance were then accepted as a basis for comparison with the fully evaluated systems from Haseltine and ITT Gilfillan.

The central assessment group's "procedural irregularities" during the final voting on which system to recommend concerned coercion and the counting of abstentions as votes in favour of scanning-beam. The CAA hurried to Washington two weeks ago to complain loudly to the FAA's executive committee (New Scientist, vol 65, p 187). "When you are kicked in a sensitive place you can't help replying with a squeaky voice," muttered one official. The FAA heard them out politely but made no comment. The executive committee meets again this week (4-6 February) to discuss all the complaints and to decide what action to take in the light of Haseltine's legal injunction against implementing the initial recommendation.

Back in London, the CAA is more resolved than ever now to go it alone with doppler if it has to. A further £1 million contract was announced last week to allow Plessey to start the final development phase of its doppler programme. And if the FAA does not have a change of heart, "a prolonged confrontation could occur within ICAO," says Plessey "with inevitable delays in the world wide acceptance of MLS in any form."

Bad news for barnacles should make shipowners happy

Two new techniques for keeping barnacles off ships' hulls could save shipowners a bundle. Barnacles and other marine encrustations on hulls are cast as villains because they increase the drag of the hull, slowing the vessel down and increasing its fuel consumption. The US Navy estimates that 25 per cent of the fuel used by a naval vessel is burnt to overcome this extra drag and weight, adding some $70 million to the Navy's annual bill. Ships cluttered up with barnacles also have to be dry-docked every 18 months or so.

But now improvements in the paints applied to ships' hulls to keep barnacles and others away could cut fuel and dry-docking bills considerably. Anti-fouling paints have been around for some time. They are based on the toxic compound cuprous oxide which slowly leaches out the paint, discouraging marine creatures from settling. But after about 14 months not enough curpous oxide leaches out to keep the barnacles at bay. The ship then has to be dry-docked, scraped and re-painted—an extremely expensive operation costing about £125 000 for a 250 000 tonne tanker.

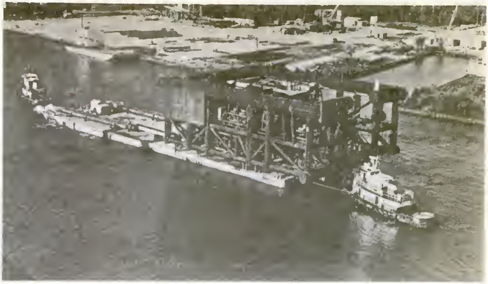
The first of the new techniques, originally suggested in 1968 by the Norwegian Ship Research Institute and developed by Jotun Marine Coatings, is a method for prolonging the life of conventional cuprous oxide paints. It involves a special paint whose top layer can be removed by underwater brushing, re-activating the release of cuprous oxide.

The new paint needs a good undersurface, so the ship's hull is first sandblasted and coated with a zinc primer followed by vinyl tar. Four coats of the anti-fouling paint, called Seamaster, are then applied to form a 250 micrometre thick layer on the vessel's sides, and a 150 micrometer layer on its bottom.

After about a year, release of cuprous oxide from the top layer of paint is almost exhausted. Automatic underwater brushing equipment then scrapes off the "dead" layer exposing new active paint. The pressure of the brushes on the hull is controlled hydrostatically to prevent the bristles going too deep, and divers can use a handheld brush to get into awkward corners. Jotun claims that a single application of Seamaster with three "reactivations" would cost £93,000, lasting about four years and saving £150 000.

Meanwhile, US naval researchers at Annapolis in Maryland will soon be starting sea trials with a new family of anti-fouling paints. Their idea is to control the rate of leaching of the toxic metal (tin) so that it lasts longer by incorporating it into a polymer chain. The three most promising organometallic polymers so far are copolymers of tri-*n*-butyltin and/or tri-*n*-propyltin with methacrylate.

Exxon sinks its oil production



Exxon's submerged production system on its way to the Gulf of Mexico

A new technique for producing oil from offshore fields is being tested by Exxon in the Gulf of Mexico. If the experiment is successful, the technology could be used in the North Sea in two or three years.

The idea behind the new development is that all the equipment needed for production throughout the life of a field is sunk to the sea-bed, and is operated by remote control from the surface. Exxon has spent £12·5 million developing the system and has just installed a prototype "submerged production system" (SPS) in a real field in the Gulf of Mexico at a water depth of over 50 metres. The SPS will tap three wells in an existing field and will link into Exxon's offshore pipeline system. The SPS is, however, designed for fields in water depths of more than 600 metres.

The essential equipment needed to control production from a field is mounted in a tubular steel template 37 metres long, 30 wide, and 12 high. After testing on land, the whole affair is put on a barge, towed to the field, and sunk to the sea-bed by blowing ballast chambers. After positioning, it is piled to the sea bottom.

Wells are drilled through the template from a vessel on the surface. Twenty or 30 wells can be drilled through one template by the deviation drilling technique used when drilling wells from fixed platforms. In principle this is simply "bending" the drill so that the well is not vertical—in practice the technique is a complex art.

The template houses equipment for gathering oil and gas, separating the two, controlling flows from wells, and pumping oil and gas to the surface. In the event of a leak, escaping oil is trapped by one of a number of "inverted drip pans" covering the equipment and a sensor is triggered which shuts down the guilty section. If the leak continues, the whole system is shut down.

Control of the sea-bed equipment is from a surface control centre, which can either be a nearby fixed platform (8-16 km away) or a vessel—probably a storage tanker which would also receive oil and pass it to shuttle tankers.

To maintain the sea-bed gear, an unmanned manipulator remotely controlled from the surface would be lowered by cable down to the template until it latched on to a cogged track on the SPS. Seven TV cameras would monitor work in progress, which could be anything from testing a valve to replacing a complete section for repairs on the surface.

The incentive to use SPS grows out of the high cost of fixed platforms for very deep waters. Because wells for an SPS are drilled from a floating vessel, they would be more expensive than those drilled from a fixed platform. But as water depth increases, the cost of a platform rises so sharply that it outweighs the extra cost of drilling. So far, Exxon is not offering SPS to other companies. But the rising costs of North Sea field development might make SPS so attractive that Exxon would find it profitable to sell the system.

Open University makes lecturers less remote

If the Post Office gives permission, the Open University may start trials during 1975 of a telephone blackboard transmission system using students' TV sets for the display of diagrams drawn on a special pad at Open University headquarters.

Two Open University lecturers, Chris Pinches and Dr John Monk, have engineered a prototype which accepts inputs from a wired ball pen (not a specially constructed writing instrument) drawing on a sketch pad and transmits digital signals over PO lines. Students in remote areas are used to conference call set-ups over the ordinary telephone and all they will require is a special modem and buffer store integrated into a black box plugged into the TV set and telephone. The cost of the device is claimed to be of the order of £150 to £200 for the student. This is about a tenth of the cost of a comparable device being developed in the US.

As provisional patents are being filed on the basic sketch pad unit, no details of how this works are being released yet. But at the students' end the TV set is driven from a 64 000 bit store which gives adequate clarity for tutorial diagrams.

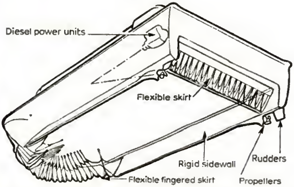
The conference call arrangements have been in force for over two years. but the blackboard development is only about three months old. The Open University has seen the rising cost of fuel for travel affect many students and has acted to bridge the tutorial gap before an impasse is reached. Wales is the favoured area for first trials of the new gadget should the PO assessment of the attachment result in permission being granted for experiments.

Remote noughts and crosses—just a beginning for the OU gadget

The sketch pad unit is said to give signals even when operated through a two inch thick wad of paper, such as a telephone directory. Tape recordings of graphical material as well as hand-drawn visuals could be transmitted by the system. For collections of students, the telephone receiver could be connected to a loudspeaker as well as the graphical decoder, so spreading the cost of the unit where travel problems exist, but where they are not acute enough to justify a unit for each student.

Pinches and Monk see the blackboard as a first step in developing a whole family of cheap devices aimed at encouraging more student participation and helping disabled students, as well as those in isolated areas.

Model of the HM 5 being tested at the National Physical Laboratory (left). Below is a diagram showing the HM 2 design and the basic principle of sidewall hovercraft



Sidewalls siddling up?

A boost for the sidewall-type hovercraft came last week with the announcement by Hovermarine of a £1 million development programme for a 160-200 seater hovercraft based on this principle. Half of the £1 million will be in the shape of a loan from the National Research Development Corporation (NRDC) through its wholly-owned subsidiary, Hovercraft Development Ltd.

Building on the success of its smaller HM 2 model, Hovermarine intends to increase its already substantial penetration of the estuarial and inshore island ferry market. But the company also sees the new vessel, HM 5, as a step towards much larger 400-tonne sidewall hovercraft which could compete against amphibious hovercraft currently plying routes across the English Channel.

Sidewall and amphibious hovercraft are basically different, although they both fly on an air cushion. Amphibious hovercraft have a continuous skirt enclosing the cushion, while sidewalls have two narrow, hulls on each beam and two skirts, at bow and stern, enclosing the cushion (see diagram) These hulls—sidewalls—are in the water even when the hovercraft is flying. This means that sidewalls can be driven by traditional marine diesels and screw systems, instead of the aero engines needed for amphibious models.

Although the sidewalls create drag, and therefore restrict the top speed of the craft, they confer several advantages. First they make control, by screws and rudders, easier by eliminating side-slip when turning—the tendency of amphibious hovercraft to plough on regardless. Second, marine propulsion and control systems are cheaper than equivalent systems for amphibious hovercraft. Hovermarine claims that amphibious hovercraft are two to three times as expensive as sidewalls—in both initial and running costs. Aero-type propellers also make amphibious hovercraft extremely noisy.

Hovermarine has sold more than 30 of its 65-seater HM 2 sidewalls to 14 countries—which puts it in the forefront of sidewall technology. HM 5 will be a scaled-up version of HM 2 involving no "revolutionary technical advances". There will, however, be differences. HM 5 will be 50 per cent bigger, not only increasing its payload (to 20 tonne), but also improving its seaworthiness. Hovermarine claims that HM 5 will be able to cruise at 35 knots in 1 metre waves, and will be "grounded" only by waves higher than 3 metres.

HM 5's engines will also be placed differently. HM 2 has three engines: two stern diesels connecting through a "V"-box to the screws and a separate lift engine in the bows. HM 5 will have two high-speed diesels mounted midships, making transmission to the screws more direct. These two engines will power both screws and air cushion. For military applications, gas turbines could be fitted lifting the maximum speed from 40 to 50 knots.

Like HM 2, the new hovercraft will have a glass reinforced plastic hull, but about 10 per cent by weight (some 500 kg) of carbon fibres will be incorporated to increase the stiffness of the grp in highly stressed areas.

HM 5 is intended for ferry work—for example to the Isle of Wight or among the Greek Islands. Its range (25 miles), high manoeuvrability, and low wash (a 6 cm wave when flying) are ideal in this use.

But as Hovermarine points out, there are no major technical barriers to building an even larger sidewall for, say, the cross-Channel route. Michael Richards, Hovermarine's managing director, put into words what many hovercraft people must be thinking: "We were delighted by the closure of the Channel tunnel project." Already, the five amphibious hovercraft plying the cross-Channel route have captured 30 per cent of the passenger traffic across the Channel. "How much more does the government need convincing?" asks Hovermarine's David Nicholas.

The greatest problem the hovercraft developers face is overcoming the reaction to the initial oversell of the whole hovercraft concept. The fact that half the finance for HM 5 is coming from NRDC —when the project is clearly not in the high risk category—is an indication of the resistance of traditional finance channels still to be overcome.

Big spenders move to reveal work hazards

The US chemical industry, shaken by the controversy surrounding newly discovered carcinogens such as vinyl chloride, is reacting by financing extensive screening of widely-used chemicals. Early in January, the Manufacturing Chemists Association announced a $500 000 programme of research on the potential occupational health hazards of styrene and vinylidene chloride monomer (VDCM—two monomers used in making plastics. Later in the month, 11 leading chemical companies announced a joint venture for screening high-volume "commodity" chemicals.

The MCA will administer the programmes on behalf of 13 companies financing the VDCM research and 12 financing screening of styrene. The work on vinylidene chloride follows initial reports from Professor Viola, the Italian researcher who first discovered vinyl chloride to be carcinogenic, that massive doses of VDCM also cause liver cancer in rats. So far, there is no evidence against styrene. The work will cover the toxicological and transplacental effects of the two monomers on animals when eaten and inhaled.

The second initiative involves the creation of an Institute of Chemical Toxicology. Although the institute has already been incorporated, final decisions about how it will operate and be financed have not yet been made.

It seems likely however that the institute will concentrate on high-volume widespread chemicals. This is because the profit margin on such commodity chemicals is claimed to be too low for individual companies to finance the research. Each company would test its own proprietary products to avoid revealing their composition.

The companies involved are among the largest in the world—Dow Chemical, Du Pont, Eastman Kodak, Exxon Chemical, and Shell Chemical are just a few. Some have their own toxicology laboratories, but these are fully stretched, so much of the institute's work will probably be carried out by contract research outfits.

Technology, like charity, begins at home

NASA is trying to keep foreign (non-American) companies from learning about NASA technology that might have "significant early commercial potential". The claim is made in the US weekly bulletin Science Trends, which says that NASA is "quietly operating" a special programme to by-pass the Freedom of Information sections of the Space Act, which make non-classified information available to anyone.

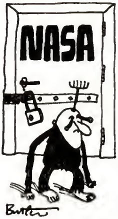
NASA operates under the Space Act and says that its policy of giving US industry the first chance at commercialising NASA technologies stems from this act. But Science Trends points out that the Space Act also contains a Freedom of Information clause, which NASA is trying to by-pass.

The "For Early Domestic Dissemination" (FEDD) programme seems to operate by restricting publication of details of NASA techniques that might have commercial applications. Science Trends quotes E. Z. Gray, a NASA administrator dealing with technological spin-off, as saying "it is essential (to give US firms first crack) that the FEDD documents do not enter the public domain through publication". NASA has so far issued 16 FEDD reports, which describe potentially useful technologies, but, according to Science Trends, has sold only 14 copies.

FEDD reports are listed in a semi-monthly NASA bibliographic catalogue, but can be bought only through six "Regional Dissemination Centers". Gray says that these centres are instructed to report to NASA when they do not know whether companies asking for FEDD reports are US-owned. He claims that at least one (unnamed) "dummy" corporation tried to order FEDD reports for a foreign power.

Libraries that hold FEDD reports are instructed not to display them publicly. And each report carries the statement: "Because of its significant early commercial potential, this information which has been developed under a US Government programme, is being disseminated within the US in advance of general publication. This information may be duplicated and used by recipients with the express limitation that it may not be published."

Most of the FEDD reports thus restricted deal with "aerospace vehicle design". One (NASA TM-X-71960), is about "Low speed wind tunnel tests of a 1/9-scale model of a variable-sweep advanced supersonic transport."



Walking on false premises

The floor this woman is walking on is in fact a computerised analytic device. It is used to study the movements of people fitted with artificial legs, at the Valenton Centre of Re-education near Paris.

The "floor" is plugged into a Data General computer. This checks the patient's identity and follows his progress across the section of test floor. The "floor" measures such parameters as the reaction of the artificial limb on impact with the ground. Every 0·01 seconds data is fed into the computer, which also takes into account the patient's weight and length of stride.

Before the computer was installed, it took staff at the Valenton centre about 6 hours to test the results of the fitting of an artificial limb. With the computer, 8 to 10 separate fittings can be carried out in an hour.

The Valenton equipment not only allows easier study of how closely a new artificial limb fits without unnecessarily tiring the patient, but also allows the patient to exercise the new limb. It also means that designers of artificial limbs can look at the movements of their patients with a view to developing new designs. Researchers at the centre, which handles 800 patients a year, hope to extend the computer analysis techniques to artificial arms and hands.

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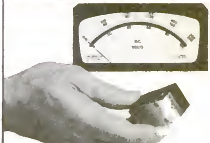

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Patents review

Adrian Hope

HOW LONG IS A PIECE OF STRING?
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A TV with two screens

John Sparkes of the Open University claims (in BP 1 342 596) a system for simultaneously transmitting two different black and white television programmes over a single colour television channel.

In the present UK TV broadcasting system, the basic black and white picture is transmitted by a luminance signal, which is made up of the sum of the three colour outputs of the TV camera. The colour information is transmitted as a chrominance signal by modulating a sub-carrier. The sub-carrier is chosen so that the luminance and chrominance signals are interlaced and no extra band width is required. The new suggestion is that one programme in black and white should be transmitted in place of the colour TV luminance signal, and another quite separate black and white programme be transmitted by modulating the sub-carrier which would normally be modulated by the chrominance signal.

Although a TV receiver with two screens would require some independent circuitry for each screen and programme, much of the basic circuitry could serve both screens. The invention could prove a valuable teaching aid with, for instance, a series of questions displayed on one screen and a series of answers optionally on the other.

Electrons on plastic discs for video recording

A clever new technique for recording sound or video signals on disc is revealed by Decca Ltd in BP 1 373 511 and 1 373 512. A disc blank, formed of conductive material coated with a thin film of thermoplastic, is rotated on a turntable underneath an electron probe. The audio or video signal to be recorded is fed to the electron probe which beams a varying number of electrons onto the plastic surface of the disc. This lays a varying charge as a spiral round the disc. The force between the deposited charge and the conductive disc deforms the plastic—depending on the strength of the charge. The plastic can be heat softened to increase the deformation, and the result is a master disc with a spiral track of ripples corresponding to the recorded signal. The master disc is then coated with a thin protective layer of metal by evaporation techniques.

The coated record can be used to produce stampers for production runs in conventional manner. Alternatively, the disc can be played in its virgin state by rotating it under an electron gun with a collector angled to pick up back-scattered electrons. The rate at which electrons are picked up by the collector will vary with the ripple variations in the groove and so reproduce the original signal.

Although the invention is clearly directed to the production of video discs with a band width of 50 MHz, the patent suggests that discs formed in this manner can be played back with a conventional gramophone stylus. Decca therefore apparently consider the process applicable, with modification, to the production of conventional gramophone records.

Cheap colour TV with liquid crystals

Liquid crystal filters as the basis for a cheap colour television system are described in BP 1 373 894 by the French Atomic Energy Commission. Most domestic colour TV receivers use shadow mask tubes with triangular clusters of red, blue, and green dots. Viewed from a distance, the individual dots merge together to produce the necessary colours. An alternative approach is to use a sequential system; a rotating disc of colour filters in front of a black and white TV tube presents a rapid sequence of red, green, and blue pictures which the eye merges together. The French inventors claim that this clumsy mechanical filter system can successfully be replaced by a single liquid crystal filter under electrical control.

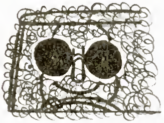
A black and white TV camera tube is focused on an object via a filter formed from a liquid crystal between two sheets of glass. The filter has a polarising screen on one side and an analysing screen on the other. When a voltage is applied to the filter the optical axis of the liquid crystal changes to vary the colour of light which can pass through onto the TV tube. Thus at any instant the TV camera produces a picture which represents the colour content of the object as dictated by the state of the filter at that instant.

A black and white TV receiver tube reproduces these pictures and is viewed via a liquid crystal filter, polariser, and analyser which correspond exactly in characteristics to those of the camera. Trigger signals for the liquid crystal filter in the receiver are synchronised with trigger signals used in the camera, so that at any given moment the camera and the receiver filters are passing only the same colour light. Thus a viewer will see on the receiver tube the same colour content that the camera views. If the trigger voltage to the crystal filters is altered so that a rapid succession of differently coloured images are produced every second, the eye will merge the images together and see a colour picture.

Blinkered vision slices through fog

Westinghouse Electric Corporation has patented (BP 1 374 790) a method of seeing through fog or cloudy water. If an object in such surroundings is illuminated with a conventional bright beam of light, much more of the light is scattered back to the eyes of the observer than ever reaches the object. As a result, the observer sees only a wall of veiling light.

Westinghouse suggests illuminating the area of the object by scanning with a narrow beam of light. The field of view of the observer is also made to scan in exact synchrony with the light beam. This can be achieved by scanning with a photographic or television camera or by moving a slit backwards and forwards in front of the observer's naked eye. In each case the result is the same. At any given moment, the amount of back scatter generated by the narrow beam and received by the narrow field of view is relatively small. But, provided that the scanning rate is fast enough to overcome the observer's persistence of vision, he will see what appears to be a full view of the object in its surroundings. This full view will be degraded only by the small amount of back scatter from the narrow scanning beam. The system could well find use not only on road vehicles but also for observing submarines.



Plastics push their way into car engines

Carbon fibre and plastic push rods between the camshaft of a car engine and its valve rockers are suggested by Henry Weslake of Sussex in BP 1 343 983. Such push rods will, no doubt, find other uses where heavy forces have to be transmitted without risk of buckling.

Weslake claims that a push rod shank with a Youngs Modulus greater than 200 GN can be formed from plastic if the mix incorporates carbon fibres. He suggests a ratio of 60 per cent carbon fibre to 40 per cent epoxy resin by weight with metal thrust transmission members secured at each end of the shank. Because of the moulding techniques which can be used to produce such plastic rods, it should be much easier to form an internal passage along the length of the shank for lubricant or cooling oil.

Are we reading right?

The alphabetic system is partially redundant for the skilled reader. Should the whole system be updated from time to time?

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Early in the Palaeolithic period, more than 30 000 years ago, prehistoric man recorded on the walls of his rock shelters pictorial representations of the animals he hunted. Notches on bone may have numbered his kills. The pictographs which may have developed from these paintings became a crude form of representational communication. Dot symbols on potsherds, later the abacus, and the knotted-string quipus still used in the South American Andes continued the development of enumeration and communication.

Pictographs gave way to ideographs. These were more stylised, less representational, and not always immediately interpretable to all observers. They attempted to portray more abstract ideas, such as the Romany symbols of Europe, certain road signs, and (in their ultimate form) the Chinese script. Where homophones occurred, such as "sale" and "sail", words with similar sound but different meaning, the concrete symbol of one might be employed to signify the abstract meaning of the other—perhaps with the addition of a distinguishing mark to indicate that the homophonous meaning was intended. Problems could arise with the development of pronunciation changes, dialect differences, and archaisms. But man had taken the first step of phonological representation.

The next advance probably resulted from the fact that the root form of words in many languages, not just the Indo-European family, was monosyllabic—typically a consonant-vowel-consonant (CVC) or CCVC cluster. Hence there were many attempts (one of the best known being Linear B of Crete) at developing a syllabary. The symbols were usually derived from ideographs. Problems again arose, however, with the large ensemble of required signs, which put a heavy load on memory, and led to considerable visual confusability between symbols. Moreover, while a syllabary can indeed cope well with words such as fa-mi-ly, words like strength can only be accommodated unnaturally and with difficulty: se-te-re-ne-ge-the.

Finally, someone somewhere developed an alphabetical system. Depending upon an awareness of the gestural or motor, rather than merely the acoustic, parameters of speech, this broke it down into those elusive, abstract, almost hypothetical constructs, the phonemes. This insight, and the fact that most alphabetic systems appear to have some common origins, suggests that it may have been invented once only. It is certainly an economical system, if a one-to-one relationship is observed between symbol and phoneme (minimal significant gestural difference), given the fact that most languages possess approximately 40 to 50 phonemes.

The main problems, however, are that the phonemic aspect of running speech is not immediately obvious, especially to children learning to read; and secondly that the natural evolution of both speech and symbol soon destroys the original one-to-one relationship. Thus in English we have redundancy (with, for example, c and k both sometimes representing the same sound) and uncertainty (as with c, which is sometimes pronounced soft and sometimes hard). This lack of strict regularity can make English orthography a nightmare for the child or foreigner to master, though oft-times an ideal experimental vehicle for psycholinguistic research. Other languages, however, such as Russian, are far more regular.

Major question

One major question relevant to both the theoretical and applied aspects of reading research is whether a skilled reader apprehends words directly from their overall shape. Or do we do so serially, letter-by-letter? Or in some intermediate fashion—for example, by apprehending clusters of letters directly, especially perhaps in certain positions such as beginnings and ends? Considerable research has gone into identifying the distinctive features (linearity, slant, curvilinearity, horizontal components, vertical components, open and closed loops, etc) that distinguish, for example, the individual letters E, F and H from O, Q, C and G.

Recent studies, however, indicate that the overall shape of words like "coquette" (rounded and largely closed in the first part, open and linear in the second) may aid their direct apprehension. This appears to be particularly true with words written in lower-case type-face, and has given rise to modern teaching methods such as "look and say". Indeed, the rate at which the skilled reader can cover the page suggests not only that individual letters are not separately fixated by the eyes, but that saccades (scanning jumps) may cover several words. While this could still permit some internal scanning process to treat each letter separately, at the rate of perhaps 10 millisecond per letter, several lines of evidence independently suggest that usually several letters, in a cluster, are processed together as a group.

The strongest argument comes from the recent work of Alfred Wheeler and Alfred Reicher in America, who have shown that individual letters such as k or d are better recognised when embedded in a word like "work" or "word", than when presented in isolation. The experimental controls precluded the possibility of redundancy from the other letters in the word aiding guessing. Indeed, Max Coltheart at the University of Reading has shown that a simple technique such as writing pSyChOlOgY is very disruptive. Other evidence suggests that our familiarity with regularly occurring clusters of letters permits us to identify them as a group, from our learning of the higher-order distinctive features that characterise their overall shape.

When uncertain how to spell a word, we often try our several alternatives to see which one "looks best". Thus, while words are composed of discrete alphabetic symbols, skilled readers may historically regress by recognising a word by its overall shape—somewhat as our ancestors did with their ideographs.

If this is so, is it possible that, in reading, we can obtain some information during each eye-fixation from words adjacent to the one currently fixated? There is now abundant evidence that much meaningful information can be obtained from peripheral viewing (New Scientist, vol 54, p 628). Such information, if obtained during reading, might be partial rather than complete, perhaps preconscious, rather than reaching immediate awareness, and maybe relating more to the ultimate significance or meaning of the word, rather than its shape or sound. Certainly there is now abundant evidence that we can do many skilled operations at a level below that of conscious awareness. This is clear from the ability of a skilled typist to perform to her boss's satisfaction, and the reader of children's stories to the satisfaction of the child, with little or no subsequent memory of the content of what was typed or read.

Experiments in both visual and auditory selective attention have amply demonstrated that unattended material, though usually preconscious and not subsequently remembered, has a subtle and significant effect upon what we consciously perceive, comprehend, and remember. In an experiment I performed while on leave recently at the University of Edinburgh, I found that the perceived meaning of ambiguous homographic words such as "box", "palm" and "yard", flashed to central vision, was determined by the presence of disambiguating items such as "fight", "tree", and "foot", simultaneously presented on a line of script beside the homograph. This was even though the readers were unable to say anything whatsoever immediately afterwards about the peripherally located disambiguating context words. Indeed, the effect was even stronger when the "unperceived" context words lay to the right of fixation rather than to the left—perhaps because in normal reading it is more profitable to seek extra information ahead, rather than behind fixation, where we have already scanned and processed the material.

Chinese ideographs

Linear B *syllabary* of ancient Crete

Road sign pictographs

Final question

A final question of both theoretical and applied significance is whether as skilled readers we identify words by recoding them into their sound (sounding out, as children or learners often do with difficult or unfamiliar material), or whether we can identify their meaning directly. The results from the Edinburgh experiment suggest that we can indeed extract information as to meaning directly. Other evidence again comes from the speed with which the skilled reader can cover the page, the fact that his mistakes tend to be substitutions of words of similar meaning rather than sound, and the fact that a sentence such as "eye do knot no y awl yew gneiss buoys so sew sloe" is so immediately confusing. Such a sentence, if we first "sounded out" each word, should be far from difficult.

Like our ancestors again, we can cope adequately with symbols such as pictographic road signs, algebraic or chemical formulae. If Chinese, we can manage a complex ideographic system. In an experiment I performed at Monash, word pairs presented on a computer display, such as "mown-down" and "worse-horse", which share orthographic (spelling) similarities and pronunciation differences, led to dysfluencies and difficulties in rapid naming only when both members were spoken aloud immediately in succession. When the first member was merely noted for remembering, the second was spoken as quickly and as accurately as when the first was a completely unrelated word.

The general conclusion, therefore, is that a skilled reader can recognise words from the overall shape of groups of letters, that information as to meaning can be obtained from more than one word in a single visual fixation, and that we do not normally need even covertly to "sound out" a word first. So what are we doing using an alphabetic code—especially when the sound-to-spelling relationships are so full of exceptions and broken rules?

Should we revive the syllabary system? There is considerable evidence that the syllable is a fundamental unit in the perception of spoken speech. Its median duration (180ms) is shared by a number of other effects. Delayed auditory feedback (DAF, or the playing back to a person, via earphones, of his speech after a short delay, which usually engenders considerable stuttering and

sink drink never lever bow cow
stone bone wart part tear fear
break weak gate fate lead bead
road broad roof hoof row cow
liner fine work fork wind binder
late water floor poorer wound bounded

Ask someone to read the above six lines of listed words *aloud* as *fast* as he can, trying not to think of how he should pronounce them. However, note whether the penultimate words in each line (bow, tear, lead etc), which can adopt two possible pronuciations, are always spoken as if rhyming with cow, fear, bead etc, or are just as often spoken as if rhyming with tow, pear, dead, how, tinder and wounded. Can we conclude that the way an ambiguous word is pronounced is not influenced by adjacent words perceived in peripheral vision? Ideally, the demonstration should be repeated, with someone else, replacing the final words with the six given above (tow, pear ...... wounded).

hesitancies) is most disruptive when delayed by the same interval. Speech is least intelligible when switched back and forth between ears at a rate of 180ms ear to ear. Moreover, the worst interaural switching rates, and DAF intervals, continue to be a constant function of the speed of artificially speeded speech.

Other evidence, from filtered speech and from grossly distorted DAF, indicates that the syllable is a basic rhythmic or stress unit employed in both the sequencing of the spoken output and in speech perception. People set to detect target phonemes or syllables in spoken material are usually faster with the latter. This implies that syllables, though made up of phonemes, are identified before them. Indeed, the general phonemon of "linguistic transparency" does mean that we cannot easily be simultaneously aware of a word both in terms of its meaning and its sound—ie, we listen to it for one or the other, and except in the case of specially constructed material as in poetry, it is the meaning alone that we normally wish to extract.

However, the existence of poetry (particularly the non-literate poetry of primitive peoples) indicates that sound can also be simultaneously important, even at the phonemic level. Otherwise alliteration, such as "Peter Piper picked a peck of pickled pepper" would not have its universal appeal. And Spoonerisms—naturally occurring but erroneous transpositions in speech, such as "Take the first town drain"—would not operate at the phonemic level. Indeed, the whole history of language evolution has been marked by the development of sound changes at the level of the phoneme. Thus corresponding to "father", we have the Sanskrit "pitar", the Latin and Greek "pater", and the German "vater".

Consequently, just as phonemes and syllables are in a sense mutually dependent on each other, for both their very existences and their definitions, so perhaps we should regard neither as being a more fundamental speech unit. Moreover, were we to adopt a syllabary for our script, we would still have to overcome the problem of a very large number of potentially confusable symbols, which could only with great difficulty and unnaturalness cope with our consonantal words such as "strength". A fluent reader who learns to read with the alphabet can skip a lot, make use of his expectancies and the verbal redundancies present, partially ignore the strictly alphabetic component, and maybe read each word as an ideogram.

Indeed, according to Noam Chomsky, whose contributions to psycholinguistics have been so generally fundamental, our orthography is a near-optimal representation not so much for sounds (there are so many sub-rules for spelling and exceptions), but for representing relationships between etymologically and semantically related words. Thus we recognise "sign" (as opposed to "sine") by virtue of the unpronounced "g" which is pronounced in the derivative "signify".

Many similar significant and potentially informative correspondences help us to build up an "interval lexicon", or dictionary of closely related words and meanings, which we use whenever we speak, listen, read, or write. Indeed, the whole process is easier for the reader than for the writer. The application of relatively few rules permits the determination of the correct pronunciation from the spelling, but it is not so easy for the writer to generate the spelling from the sound. Thus any revision in our orthography should take care not to obscure such useful semantic interrelationships as in sign/signify.

Improving our script

So how should we improve our script? While the alphabetic system may be partially redundant for the skilled reader, it can provide a guide to pronunciation, where required, as in learning to read, and it does employ a limited number of discrete symbols for memorising. If necessary, the characters could be redesigned to reduce inter-item confusability, and to maximise the number of distinctive features operating for identification at the letter-cluster level.

While it might seem opportune, as George Bernard Shaw requested in his will, to provide a unique symbol for each phoneme, and to reduce certain redundancies, we could still in our spelling attempt to highlight etymological or lexical commonalities of the "sign/signify" sort. We should perhaps periodically update the whole system. This could be done on two occasions: first, when hitherto-related dialects become so disparate as to warrant being described as separate languages (for example, Spanish and Portuguese, but not yet English and American) and secondly when the ordinary reader loses sight of ancestral common etymological origins. Thus the "gh" in "night" no longer serves a useful purpose, as the dialects and languages where it is still in some form pronounced are now distant or extinct (for example nacht and nocte).

Energy file

Michael Kenward

US politics

ERDA the one

The Energy Research and Development Administration of the United States officially started work just over two weeks ago, on 19 January. ERDA was established under the Energy Reorganisation Act of 1974 to bring together federal activities in energy research and development, and assure coordinated and effective development of all energy sources. President Ford has made Dr Robert Seamans head of ERDA. Six assistant administrators have been nominated by Ford to take responsibility for the following areas of R&D: fossil fuels; nuclear energy; environment and safety; solar, geothermal and advanced energy systems, including thermonuclear fusion; national security; and energy conservation.

Seamans has been Secretary of the Air Force and Deputy Administrator of the National Aeronautics and Space Administration, and more recently president of the National Academy of Engineering. As ERDA administrator he is responsible for R&D programmes involving all energy sources. This includes such things as demonstration of commercial feasibility and practical application of fossil, nuclear, solar, and geothermal energy, and the demonstration of methods to reduce energy consumption and improve energy use efficiently.

	FY 1974 (Actual)	FY 1975 (Estimate)
	($ in millions)	
Fossil energy development		
Coal	62·6	187·4
Oil and gas	8·0	17·3
Oil shale	2·8	3·6
Total	73·4	208·3
Solar, geothermal and advanced systems		
Solar	3·9	8·8
Geothermal	6·5	14·8
Advanced systems	4·2	12·3
Physical research	309·7	323·0
Total	324·3	358·9
Conservation		
Electric power	1·6	6·7
Fuel economy	3·3	10·5
End use	—	—
Total	4·9	17·2
Nuclear energy development		
Fusion	57·5	105·3
Fission	434·8	589·7
Naval reactors	217·1	186·2
Space	34·5	30·2
Nuclear materials production	744·6	908·5
Advanced isotope separation	3·5	14·6
Total	1492·0	1834·5
National security		
Total	964·6	1071·9
Environment and safety		
Total	138·0	205·6
Grand total	2997·2	3696·4

ERDA brings together programmes and personnel from other federal agencies. These include: from the department of the interior, fossil fuel energy research and development programmes such as those conducted by the Bureau of Mines energy centres, including offshore drilling technology, oil shale production techniques, oil and gas secondary and teritiary recovery, and conservation; also the Office of Coal Research programmes, including coal liquefaction and gasification, and research on underground electric power transmission. From the National Science Foundation, ERDA takes over solar energy R&D, including wind and ocean thermal, and geothermal, energy. The AEC hands over nuclear fission and fusion R&D, nuclear weapons activities, uranium enrichment, physical, biomedical and environmental research, including waste management, and AEC's programmes in geothermal and solar energy, electrical transmission and storage, and underground coal gasification. ERDA takes over R&D on new automotive power systems and alternate fuels from the EPA. The new agency is taking on 7222 people from these Federal agencies. This is a massive underestimate of the number of people involved because most of the R&D is carried out under contract. According to Seamans "there are a very large number of contractor operations tied in with what was the AEC, and is now ERDA. These number about 90 000, located at such well-known places as Oak Ridge, Hanford, Livermore, Los Alamos, and so forth."

Seamans clearly believes that energy conservation has to become more important. "I feel, as a result of studies carried out when I was back at the National Academy of Engineering, that there is no way we can become self-sufficient in 10 years or at any time in the future if we keep increasing the use of energy at what has been the past rate, namely, a little over 4 per cent per year." With the spending on conservation R&D running at $17 million during the current fiscal year (FY75), which is "much too low", we can expect to see much more money spent in this area in future. But it is very difficult to know where to spend money on energy conservation. "My feeling is that you don't get anything done by just putting in money. You have got to have well thought out projects and, in the case of conservation, I think it is more difficult to find the proper role for the government than in other areas. So I look for the next year to be one of extensive planning and analysis, where what might be called the strategy for conservation can be thought through."

The energy R&D budget has been rising rapidly, as the figures for the 1974 and 1975 fiscal years show (see table, the fiscal year starts on 1 July). The proposed budget for FY76 was issued on Monday (3 February). In this the total ERDA budget is set at $4974·3 million, broken down as follows:

fossil	$331·7 m
solar	$475·8 m
conservation	$34·7 m
nuclear (+ fision)	$2243·7 m
national security	$1101·7 m
environment & safety	$231·0 m

(This does not add up to the total budget because some small items are included in a separate "Programme Support" budget.) Fossil fuels will, if Congress accepts the budget proposals, experience the largest increase, with coal R&D rising to $279·5 m in FY76. Solar R&D rises to $57·1 m. National security spending in FY76 includes $54 m for laser fusion R&D.

Nuclear watchdog

The AEC's role as nuclear watchdog has been taken over by the Nuclear Regulatory Commission. In this way the US government is meeting the criticism aimed at the AEC, which was acting as both advocate of nuclear power and guardian of the public safety. Before the anti-nuclear campaign got under way the AEC was not as diligent as it might have been in its pursuit of public safety. ERDA will now look after the technology side of the nuclear programme. The NRC also started work on 19 January. The chairman of the new commission is William Anders; Victor Gilinsky, Richard Kennedy, Edward Mason, and Marcus Rowden are NRC commissioners. The organisational structure of the NRC is described as "transitional".

Coal

Independent advice

The recent tripartite study of the future of Britain's coal industry, conducted by the National Coal Board, the Department of Energy, and the coal workers' unions, said that the NCB should go ahead with a series of coal R & D projects that would cost £20 million over the next five years (see Energy file, New Scientist, vol 64, p 502). Professor J. R. Glastonbury, until recently visiting professor at the University of Cambridge, believes that this should not be the last word on coal R & D. He says that "while there are groups within the NCB and elsewhere assessing the more immediate and the very long-term situations (the turn of the century and beyond) the apparent lack of review of the mid-term situation is a matter of serious concern" (The Chemical Engineer, January 1975, p 26).

Glastonbury says that there is "too little concern with the way in which future coal production will be utilised". For example, we are not thinking seriously enough about the best use that should be made of coal from the new Selby coal field. The NCB assumes that the coal will be used "in the traditional manner". There is "a strong case" for "a large central coal processing unit which would be able to obtain more effective utilisation of a portion of the coal production". The coal could be used in a low-temperature, fluidised bed pyrolysis process. This would produce carbon char, gas, and byproduct chemicals. The char might feed a further gasification plant, or fuel a fluidised bed combustion unit.

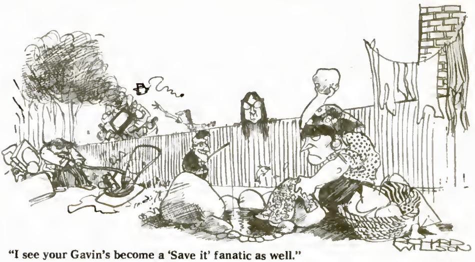
Britain should not worry about coal liquefaction; nor should it spend too much effort on turning coal into synthetic natural gas. To a certain extent the tripartite study agrees with Glastonbury. It commended work on pyrolysis, solvent extraction (which might be used for in situ recovery), and fluidised combustion. Projects on coal gasification and development of metallurgical fuels were rejected. Glastonbury feels Britain should develop commercial scale "formed coke processes to replace metallurgical coking operations".

Publications

Foreign policy

The latest in the series of reports from the Energy Policy Project of the Ford Foundation is "Energy and US foreign policy", by Joseph Yager, Eleanor Steinberg, and a team of colleagues at the Brookings Institution. The report looks at different areas of the world and the ways in which their energy policies are developing. It points to the difficulty of getting anything done in Europe, where the EEC's "exceedingly optimistic prospectus" talks about a developing energy picture that finds absolutely no credence or support among member nations. "Decision making in Europe is a ponderous process," says the report. "The advantages and disadvantages of various approaches to energy or oil policy are not at all clear. Unilateral action seems to be of limited worth and multilateral measures are difficult to organise."

As far as the US is concerned, the report dismisses complete energy independence as an unrealistic goal because of the political costs and other drawbacks. The report also takes potshots at particular projects in the US energy R & D repertoire.


"I see your Gavin's become a 'Save it' fanatic as well."

For example it doubts the wisdom of the massive breeder reactor programme under way in the US. The authors believe that the proponents of the breeder have not thought through the implications of their actions. The report points to the massive increase in the amount of plutonium that will be generated in a breeder programme—safeguards implications are the major foreign policy issue for the breeder. The report says that "during the present stage of intensely competitive and nationalistic breeder programs, which offers little hope for forging international control or cooperation, the United States could most effectively influence events by slowing down its breeder program in order to reevaluate the merits of breeder reactors".

The Energy Policy Project's reports are published in the US by the Ballinger Publishing Company, 17 Dunster Street, Harvard Square, Cambridge, Massachusetts 02138. In Britain John Wiley has issued some of the earlier reports, but wasn't quite sure when asked if it will publish the complete series. All 20 volumes are being issued in both paper and hard backs.

Foratom piece

A complete guide to the nuclear industry in Europe has recently been published by Deutsches Atomforum on behalf of Foratom (Forum Atomique European, the "club of clubs" that brings together the national industry groups). The report (The Nuclear Power Industry in Europe) has a short summary of the status of nuclear power in Europe, a survey of European cooperation in the field, and detailed descriptions of the nuclear industries in Foratom's 14 member countries (all national reports, apart from the French contribution, are in English). Each national report lists the companies, and utilities involved in the nuclear business, with addresses and telephone numbers. Copies of the report are available from national Foratom members. (In the UK the British Nuclear Forum, 8 Leicester Street, London WC2, will sell you a copy for £10.)

Last report

You can complete your information on the nuclear industry with what must be one of the last reports from the US Atomic Energy Commission before it merged into ERDA. Each year the AEC issues a report on the industry and the latest report has just come out (The Nuclear Industry 1974, WASH 1174-74).

The report tells us that "the magnitude of American investment in nuclear power can be best illustrated by the fact that over $102 billion are presently committed to the nuclear power program. Forecasts indicate that by 1985 uranium will fuel nearly 30 per cent of all domestic electric power generation, and that by the end of the century it will supply more than half of our greatly expanded needs for electricity."

There isn't much in the report about the role of the nuclear intervenors in the US. While the near bankruptcy of some electricity utilities has led to extensive delays and cut backs in power station construction, the US can thank the critics of nuclear power for smoking out a good deal of hitherto unavailable information. The report merely relates that "steps taken by the AEC over the past three years to provide meaningful public participation in the regulatory process and to release full information on matters of concern constitute an unprecedented approach to involving the public in the regulation of industry. These steps follow Commission policy that a regulatory process to protect the public interest must be carried out publicly, and that public participation and understanding are vital cornerstones for effective regulation of nuclear energy." (Any member of the public who wants a copy of The Nuclear Industry 1974 can obtain one from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402. The report costs $1·90 per copy.)

Feedback

UK oilmaker to cut high rape levels in cooking oil

Illegal in Italy, unacceptable in Canada, but legally on sale in Britain

Britain's largest producer of vegetable oils announced on Monday that it is to cut the amount of erucic acid from rape-seed oil in its blended cooking oils. Erucic acid is suspected of causing heart damage and was the subject of an EEC warning last month (see Feedback, 16 January, p 149). Erucic acid occurs only in rape seed and not in soya, maize, or other oil seeds.

The firm, J. Bibby & Sons of Liverpool, took its action after it was told that New Scientist was to publish data showing that at least one of its oil blends would be illegal in Italy and unacceptable in Canada. Its action also reflects its discovery last Thursday that large quantities of low erucic acid rape seed are now available.

For the consumer, it will probably be about two months before the high erucic oil disappears from supermarket shelves. Even then, without an indication of erucic acid on the label, it will be impossible for consumers to tell just what they are buying.

Vegetable oils are triglycerides, in which three molecules of fatty acid are linked to one of glycerol. Thus, oils are about 90 per cent (by weight) fatty acids. Most fatty acids in vegetable oils are broken down in the body much more readily than the saturated acids from animal fats, which is one reason why people with high blood cholesterol or high blood fat are often told to switch from animal to vegetable oils.

But erucic acid is unique among the vegetable fatty acids in that it does not break down very far, according to Dr Rodney Watts of the Department of Experimental Pathology at Birmingham University. Animal experiments have shown that the erucic acid accumulates in heart tissue and leads to the deterioration of that tissue, he said. Other animal tests suggest that erucic acid is linked to growth retardation, although there is no evidence as yet linking this to people.

"It is the people who are being health conscious who are in the most trouble," Watts continued, because to avoid cholesterol they switch to vegetable oil which in fact damages the heart. Of one oil he tested, Watts commented: "I would rather eat butter any day than this oil."

Tests by Watts and others seem to indicate that oils with low levels of erucic acid cause much less damage in animals. Thus, the question is what level should be set for the acid. The EEC document suggests only "low levels".

In Italy, the legal maximum is 15 per cent erucic (as a percentage, by weight, of all acids). In Canada, where rape is much more widely used, there is a voluntary limit of 5 per cent.

Bibby has used up to 80 per cent rape oil in its blends, and a bottle of Bibby-manufactured Lipton Sunshine tested six months ago by Watts had 35 per cent erucic acid. A bottle of Sunshine purchased from a Lipton supermarket in Birmingham two weeks ago contained 15·3 per cent erucic acid according to Watts—enough to make it illegal in Italy. Confronted with these numbers, Bibby issued a statement saying merely "we are conservative in our selection of ingredients".

But 80 per cent high erucic rape did not seem particularly conservative, and on Monday Bibby announced that henceforth its oil would contain less than 10 per cent erucic. The changeover would take about two weeks, and it will take at least five more for the oil to find its way to supermarket shelves. In addition, food companies will still be able to specify high erucic oil, especially if it is cheaper.

Despite the fact that Bibby's level is double that in Canada, Watts calls it a "sensible level", although he hopes to see a much lower level eventually. One reason why this level is reasonable is the relatively low rape oil consumption level in Britain—Italy uses three times as much per capita, for example.

Bibby is the largest oil producer in the UK, and thus its decision will have a significant effect on erucic acid consumption. But it is also significant because other large manufacturers use little rape oil—Spry Crisp 'n Dry, with 14 per cent of the liquid oil market, is limited to a 15 per cent rape-seed oil (2·7 per cent erucic acid) "for reasons of taste as much as anything," according to a spokesman.

Rape seed consumption in Britain has remained steady for the past few years, but production has changed radically. Last year was the first time Britain imported less than half its rape seed. And this winter, nearly half the UK rape-seed crop is low erucic (less than 10 per cent erucic acid) according to Michael Dayus of John Bryant (Romsey) Ltd, which sells over half of the rape seed to UK farmers. The change is all the more dramatic because less than a year ago the seed was virtually unavailable.

Dayus noted in passing that even Bibby did not know that this much low erucic rape would be available until it rang last Thursday to discuss the need to cut erucic acid in its oil immediately.

Rape seed oil can be as high as 50 per cent erucic acid, and international and British markets do not distinguish between high and low erucic rape (those in Canada and Sweden do, which leads to those countries exporting their high erucic rape to Britain). Further, there is no particular pressure on British farmers to use low erucic rape seed—the high use this winter is only because that was the seed supplied by Bryant, in its own attempt to lower erucic acid levels.

Even lower erucic rape is now being grown in Canada, Professor Watkin Williams of Reading University said that a seed was now available in Britain with less than 1 per cent erucic, although it was limited at present by a 15 per cent lower crop yield.

Meanwhile, the levels of rape seed oil and erucic acid in cooking oil will still be determined by market forces. Most cooking oils are composed of maize, soya, and rape oils, sometimes as single oils and sometimes blends. Those which do not specify one particular oil sometimes contain a high percentage of rape. But the amount can vary radically from week to week, as oil prices vary—sometimes by as much as 10 per cent in a day, according to David Airey, general manager of Bibby's edible oils division. Within the last year, rape has been both cheaper and more expensive than soya, and at the moment there is apparently a slight soya bean shortage. But it does look as if the erucic acid content of oil will drop sharply in the next few months.

Joseph Hanlon

Sex in Nature

Is Nature, the weekly publication, making a bid for a place on Britain's bookstands next to the Mayfairs, Knaves, and Men Only's? First reference in a paper in last week's issue on "Marijuana, absinthe and the central nervous system" is to "Zolotow, M., Playboy Magazine, 18, 169 (1971).

Or perhaps Nature has set its sights on the Soho magazine shops. Another paper in the same issue is titled "Thermal effects in the necking of thermoplastics" . . .

US embassy keeps tabs on British R & D again

Last week's statement by Elliot Richardson, the former Nixon Attorney General who resigned over Watergate and who is now ambassador-designate to Britain, that the British "are far too valuable, not only for themselves but for the world, to be allowed to suffer from the stresses of an interdependent economic situation", is not the only recent American action which might cause a flicker of pride to surmount the prevailing gloom in British breasts. For the US embassy in London also has a recently appointed science attaché, whose calibre suggests that British R & D may be worth watching on a slightly more salubrious level than that at which the CIA usually operates (see Feedback, 16 January, p 148).

Dr John Hulm is taking leave of absence from his job as a research director with Westinghouse, to be the US's official observer of British science and technology. This follows a substantial gap since the departure of the previous US science attaché, Alan Mencher, who is now at the London Business School, researching into the effects of Mr Benn's last-time policies as head of MinTech. It also represents a change in State Department practice in that Hulm is possibly the first science attaché to have been drawn from industry, rather than from the diplomatic service or university circles.

It might also seem strange to many countries with a more nationalistic outlook to learn that a US attaché to Britain has, in a sense, come home to take up his post. Hulm was born and brought up in the north of England, and went to the States after completing a PhD in low-temperature physics at Cambridge.

After five years at the University of Chicago—where, at that time, physicists came into daily contact with "names" such as Enrico Fermi and Marie Goeppert-Mayer — who proposed the shell theory of nuclear structure—he moved to Westinghouse. There, among other things, he set up the team which started the company's work on superconducting generators. On a completely different tack, he was also responsible for the "human factors" group, which has been looking into ergonomic approaches to technology—not only designing advanced equipment, but making sure that the control panels, for example, are, in a literal sense, "handy".

The London job might seem a slightly toothless occupation after the rough and tumble of Westinghouse; but Hulm is not too worried about this. He has, he says, taken on similar roles within his old company from time to time. At the moment, he is still finding his way around the US diplomatic system and the British R & D framework. The task is complicated because, during the embassy's gap without a science attaché, the tasks were spread around other people, and Hulm is still trying to round them up.

John Hulm is the sort of person who would pack up and go home if he found that his job was not worthwhile—something which perhaps could not be said about all the former scientists on the diplomatic circuit. But, with Elliot Richardson coming to London, there could be some dramatic changes in the role of the US embassy in London, which will go rather further than Mr Annenberg's famous "refurbishing".

Another new factor is the increased status of international scientific affairs in the US State Department. This springs from the appointment of ex-AEC boss Dixy Lee Ray as head of the Department's Bureau of Oceans and International Environmental and Scientific Affairs (New Scientist, vol 64, p 431). One activity which Hulm would like to reinstitute is the embassy's briefing sessions for British journalists and other interested parties with top US scientists, and Ms Ray is high on his list for such a relaunch.

Rumour has it that the White House Office of Science and Technology, closed down by Nixon, may soon make a new appearance. Taken together with the appointment of someone like John Hulm to the London job, it may be that Britain's science policywatchers are going to have to pay a significant amount of attention to the American scene again, after the lull of the past two years.

US funds Soviet emigré's research

The US Navy is contributing $100 000 towards the research of a Soviet scientist now living in Israel. Professor Yermiyahu Branover worked on magnetohydrodynamic (MHD) generation for 15 years before leaving the USSR. Since moving to the Ben-Gurion University of the Negev, he has built two experimental MHD generators. The advantage of MHD is its much higher efficiency compared to conventional methods of power generation. As such it holds out the promise of enormous fuel savings. But, as Branover himself points out in a press release, it can also be used for nuclear generators, space vehicles and missiles.

The US has its own MHD research programme, though, unlike the Soviet one, it has concentrated up to now on the separate development of MHD generators and the auxiliary components. The Soviet Union, in contrast, has been operating an experimental industrial MHD unit over the past four years and this has been feeding small amounts of power into the Moscow grid. Branover recently visited the US Navy's Research and Development Institute in Philadelphia. Whether the fruits of his research are intended to make a direct contribution to American military technology, or are seen as part of the US military and economic commitment to Israel, is not clear.

Immigrant scientists from the USSR are certainly a source of new vitality for Israeli universities, helping to expand existing departments and develop new ones. The Ben-Gurion University offers them considerable scope, especially to those like Branover working in the more applied branches of physics and chemistry relevant for the university's raw materials programmes. The university has also absorbed seven pure mathematicians and is now hoping to develop an Institute of Applied Mathematics on the strength of Soviet immigrants.

Funding is a key problem in the universities' ability to exploit the newly arrived expertise, and is particularly acute in the current economic crisis. Israel, however, has a long history of foreign endowments for academic research, and news of the US Navy's grant to Branover must be a cheerful augury.

Dan damns Denim

IT WAS ONLY A JOKE.
DEN.

New Scientist columnist Dan Greenberg, who has more than once been accused of muckraking by the scientific community, launches a stirring, front-page attack on "the pseudo-muckrakers" in the latest issue of his Washington-based news-sheet, Science & Government Report. Picked out for particular disapprobation is Dr Sue Denim, authoress of "Dirty tricks in science" (New Scientist, vol 64, p 925).

Referring to New Scientist as a "usually sensible" publication, and Ms Denim's article as a "contribution to public misunderstanding of science", Greenberg picks out one or two quotations from the article, then concludes that "the established institutions of science should, of course, make certain that their own skirts are unblemished, but once having done so, they ought to make these folks come forth with details or shut up."

Before stamping his foot quite so hard, it might have behoved our columnist, as a percipient observer of the complexities of human frailty (as he might express it), to consider that an article published at Christmas might not be of wholly serious intent—a postulate to which further weight might have been added had he rolled Ms Denim's name around his tongue a bit, before licking the end of his quill and attempting to set the world to rights.

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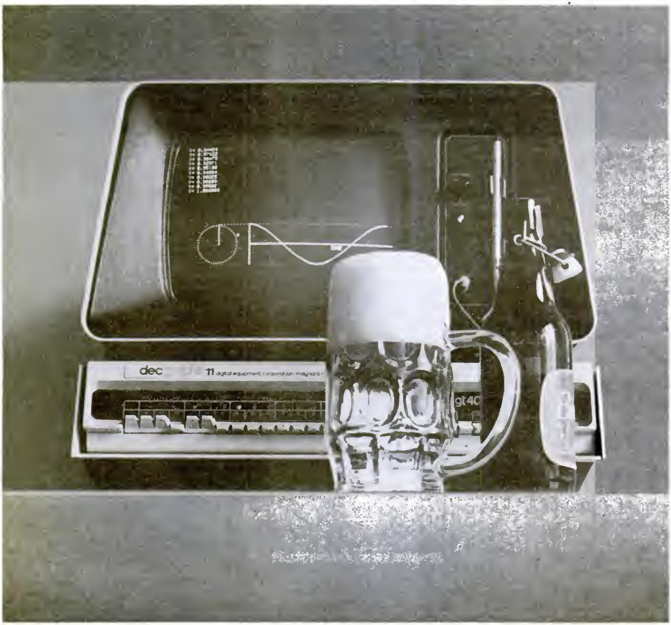

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Forum

Westminster scene

Breaking into Japan

Every year, in the huge ballroom of the Grosvenor Hotel in Park Lane, (famous as the second most expensive card in the game of Monopoly), the Society of Motor Manufacturers and Traders holds a resplendent dinner, at which some major mogul of the motor industry such as Gilbert Hunt, Donald Stokes, or Raymond Brookes, gives us a weighty deliberation on the state of the British motor industry, and what the government ought to do to help. What is less generally known is the fact that SMMT gives regular working and properly less splendid lunches to selected groups of MPs at its headquarters at Forbes House, Halpin Street, for a two-way-traffic-in-ideas on the problems facing this vital industry. An example of the use to which these meetings are put comes from Ray Carter's recent Adjournment Debate on the motor car trade with Japan, raised by SMMT at a pre-Christmas meeting, and properly explored by the MP, who has Austin-Morris in his constituency. Carter listed eight areas of restriction of the ability of our car industry to export to Japan. First, the extreme difficulty the British manufacturers come up against in the matter of type approval, and the interpretations of the drafts of those type approvals—that is, the various standards that a car and its components must meet, according to the standards of the country concerned. Secondly, delay in getting design approvals for foreign vehicles; anyone who wants to export a car to Britain must receive approval of design specification from the various standards bodies here, but we do not indulge in delay to protect home manufacturers. Thirdly, Carter asserted that any slight change in the design of a British car or of any part has to take a long time to be examined by the Japanese before it receives ultimate approval. Fourthly, Japanese authorities show an inadequacy in notification of changes in Japanese design requirements; this makes it difficult for British manufacturers to retool or to redesign cars they hope to export to Japan. Fifthly, said Carter, Japanese emission requirements are found by British manufacturers to be over-stringent, demanding a far more complex standard than anywhere else in the world. (Here my sympathies are entirely with the Japanese, since the smog in the Tokyo-Yokohama complex has been worse than anywhere else in the world.) Sixthly, Carter said that British manufacturers had found extreme difficulty in making the necessary financial arrangements in Japan to sell cars—in his view one of the most critical points. Seventhly, compared to other parts of the world there were close links in Japan between the manufacturers and the dealers; he had been assured by people in a position to know that it was almost impossible for foreign manufacturers in Japan to break into that spiral, and obtain outlets for their products. Finally, Carter thought that even if a manufacturer got a foreign car into the Japanese market, there was a high mark-up which made it prohibitive from a sales point of view. Replying, Eric Deakins for the Department of Trade said that whereas until the mid 1960s the Japanese market had been highly protected, unfortunately it was not realised now by British firms how much the Japanese market had been liberalised.

* * *

In 12 years as an MP, the problem of industrial effluent charges has been brought to my notice perhaps three times, including one imaginative scheme in the mid 1960s, through which it was envisaged that there might be a communal disposal unit for all firms to be set up on the new trading estate at Broxburn. In the past six months, many cases of the cost of effluent disposal have come to the notice of MPs. The most dramatic is perhaps that of Boots, which pumps 1 200 000 gallons of effluent, mostly the waste from pharmaceuticals manufacture, from its two Nottingham factories, every working day, into the Trent. Until recently it cost Boots a reasonable £50 000 a year for the local authority sewage works to cope with this output. Now the Severn-Trent Water Authority has told the company that the charge for 1975 ought to go up to £250 000. For firms even of the size of Boots with many inflationary pressures and in the straitjacket of the Price Commission, this is a significant item. Gordon Oakes, Under Secretary at the Department of the Environment, tells me that the Steering Committee under Professor Jukes, has recently submitted a report, containing recommendations for the rationalisation of trade effluent charges. The nub of the report is that water authorities should aim to produce a more equitable and consistent basis for apportioning sewage and sewerage treatment and disposal costs between dischargers, according to the costs they impose upon the system. In order to do this, water authorities will have to determine incremental costs, and then introduce marginal charges which would reflect these costs. The truth is that the days of effluent disposal on the cheap are over for ever and ever.

* * *

Parliament has a wide variety of quaint customs, most of which have some basis on rationality. For example, endless questions asking ministers and the Prime Minister to pay an official visit to such and such a place, arise out of the fact that a minister can only be questioned on subjects for which he has a responsibility. In the late 1960s, in order to "get at" the Prime Minister in public and officially on the issue of potential RAF staging posts in the Indian Ocean—with bad ecological effects on giant tortoises, pink-footed boobies, and flightless rails, to say nothing of HM Treasury—I had to ask him to pay an "official visit to Aldabra." Pointing out that he would have to spend three days in a boat going from Mauritius or the Seychelles, and three days back again, Mr Wilson good humouredly declined to do so—but the point was made. Now Hector Munro (Dumfries) Conservative front bench spokesman on sport, has an even less reasonable request, but an equally valid point—he wants the senior Scottish law officer, the Lord Advocate, to pay an official visit to Rockall. He said good-naturedly that Ronald King Murray's lack of plans to go to Rockall was a pity, since he might have undertaken a hang-gliding course. But would the Lord Advocate publish a document setting out our precise legal rights around Rockall in relation to fishing and oil exploration? Munro thought that friction was building up with Denmark, and that it would be better to clarify the position at the earliest opportunity. Murray said that our own limits were set out in the 1964 Fishery Limits Act, and that "Rockall generates its fishing limits, like any other part of United Kingdom Territory." In plain language, Rockall fishing is ours. As regards the exploitation of the continental shelf, the Caracas conference on the Law of the Sea was inconclusive. "Nevertheless, under the present international law, in the government's view, the island of Rockall generates its own continental shelf," and, added the Lord Advocate, "we are content to rely on that basis for the exploitation of oil and other purposes." At Geneva, and phase two of the Law of the Sea conference, we shall see. *Tam Dalyell MP*

New York view

AAAS in the doldrums

In the heady days of the 1960s when US science was experiencing a time of expanding finances and spectacular results, the annual meeting of the American Association for the Advancement of Science was a veritable showcase for the brave new world of rampant science and technology. True, the meetings of those days had their share of nebulous sociological waffling and general gobbledygook, but among the hot air was more than a smattering of results important enough to keep both the scientists and science writers on their toes. In recent years, however, much of that sense of significance has gone from the AAAS meetings.

Budgets for science are down, results are coming more slowly than in the past, and scientists generally prefer to reserve those results for the smaller, specialist meetings. As a result, the waffle content of AAAS meetings is higher than ever, and many of the papers and sessions have the ring of familiarity. Last week's 141st annual meeting of the AAAS in New York City was a typical example. What excitement there was seemed to be generated more by the bizarre fringes of science than by new fundamental insights of the type that regularly featured at the meetings a few years back.

One of the more illuminating sessions of the meeting was a panel discussion of science policy in a changing political environment, which featured a number of former White House functionaries with experience in science policy-making. Part of the discussion centred around the decision by President Nixon, two years ago, to dismantle his personal presidential science advisory apparatus, and in effect to demote the scientific community to a place outside the corridors of power. At the time, influential scientists widely suspected that the decision was a matter of Nixonian pique that led him to clamp down on a group of professionals who appeared to oppose him at every turn on such political issues as the Vietnam war, the supersonic transport, and the anti-ballistic missile system.

The Administration denied this strongly, claiming that the reorganisation was merely a means of reducing an over large White House staff. But at last week's session, two former Nixon aides made it clear that the scientists' dark suspicions were perfectly correct.

"There was definitely a falling out between the scientific community and the president," said Edward David, who was Nixon's last adviser before the demise of his office and staff. "One thing you can do if you want to reform an institution is get rid of it." Clay Whitehead, who was director of the White House Office of Telecommunications Policy at the time of the reorganisation, agreed with David. "The Nixon White House perceived, and I think correctly, that the scientific community had axes to grind that were different from those of the Nixon White House," said Whitehead, who traced the hostility between the Administration and the scientists back to the presidency of Lyndon Johnson.

Happily for the scientists, both men seemed confident that President Ford will take a more relaxed attitude towards his scientific constituents. "President Ford has made it very clear that he felt the arrangement [for science policy] when he took over were not adequate," David told a news conference. And Whitehead added his opinion that the Ford White House certainly seems receptive to scientific advice. But when a Science Adviser will return to the right hand of the President (New Scientist, 16 January, p 150) remains an unanswered question.

On the sociological front, two well-attended panels concerned the occupational health risks of women, and human sexuality in perspective. In the former, Pennsylvania State University biologist Vilma Hunt argues that the occupational health profession is paying next to no attention to the particular risks that women might be facing from a variety of on-the-job situations.

Women might react quite differently from men to specific chemicals and types of working stress, Hunt argued, but sex differences are hardly ever considered in studies of such dangers. On the other hand, other speakers declared that employers are all too ready to dismiss or exclude women from particular jobs, on the grounds that they are too weak physically, or likely to become pregnant and thus expose their unborn children to danger. Too much protective legislation aimed at keeping pregnant women —or women likely to become pregnant —away from putative risks, said Dr Jeanne Stellman of the Oil Chemical and Atomic Workers Union, could ultimately discriminate against women by reducing their job opportunities.

In the arena of sexuality, experts at the AAAS last week generally agreed that the sexual revolution is just about over in America, as the avant-garde swingers of the past few years discover that their life style is simply not living up to its promise of anxiety-proof freedom.

"The movement of American society toward reducing sex to animal-like conduct between people is about to end," declared Columbia University sociologist Amitai Etzioni. "Increasingly the separation of sex from affection is being discovered by the avant garde of sexual liberation to result in frustration, tension and jealousy." Etzioni reached his conclusion on the basis of interviews with 250 "singles" in his New York's trendy Greenwich Village section and 50 couples from the nearby Rutgers university who had decided to marry after extended periods of living together. His view was echoed by Robert Kolodny of the Reproductive Biology Foundation in St Louis —the Masters and Johnson centre—who has interviewed hundreds of couples in recent years. "We have found that a strictly mechanical hedonistic approach to sex, while espoused by some, is rapidly falling to the wayside," Kolodny reported. "Swinging seems to be declining, and people are looking for committed relationships, where there can be a positive emotional return."

Moving from the sublime to the ridiculous, as it were, there was plenty of interest in the scientific fringe, at sessions on parapsychology and the purported abilities of plants to feel emotions. For the most part, scientific orthodoxy triumphed. One panel of parapsychologists came out firmly on the side of the establishment, with warnings on the dangers of commercial courses designed to improve their subjects ESPs. "A certain number of those who have undergone such training emerged with ideas which would normally be regarded as paranoid in character," warned parapsychologist Rex Stanford of St Johns university. And the claims of lie detector technician Cleve Backster to have detected feelings of fear and sorrow in plants using polygraphs ran into a scientific brick wall, with reports of total failures by scientists to duplicate Backster's results. *Peter Gwynne*

EEC notebook

The Commission fights back

The EEC Commissioners, brunt of every bad joke in the Community, are plainly tired of being blamed for each new disaster that overtakes the Community. At least they can no longer be accused of being faceless Eurocrats. Recently they have taken every opportunity to travel the Nine speaking to anyone who will listen. The gist of their speeches is that they do everything asked of them—sometimes more—and if the politicians do not act on their advice that's their lookout. At the same time they bitterly resent the lack of political support.

The British Commissioners, Sir Christopher Soames and George Thomson, have had the seat of their pants warmed by Peter ("Get-us-out") Shore, but they are unabashed. The Agriculture Commissioner, Petrus Lardinois, regularly has stand-up rows in council. He almost caused a walk-out recently when he accused the ministers of being in the pockets of the sugar refiners.

The President of the Commission, François X. Ortoli warned the press a couple of weeks ago that Europe was in danger of being crushed between the USA and the USSR, and Albert Borschette, Competition Commissioner blasted a recent Luxembourg engineers' meeting with the message that if the politicians do not pull their finger out, "developments in this bi-polar world will place our states under a hegemony in which sovereignty will be eroded to a point where they will not even be free to choose to whom they wish to belong or whose satellite they wish to become." Are you listening Mr Benn?

Mr Borschette, a most unlikely tub-thumper, was clearly angry. Four million standing in the dole queues of Europe . . . more caviar, foie gras, champagne than ever guzzled last Christmas . . . The Arabs carving up the best of European industry . . . and still most council meetings dawdle on to inconclusiveness. An indignant Mr Borschette illustrated the Commission's frustration with the sorry tale of the energy crisis.

As early as 1970, he said, the Commission recognised that the oil producers' conferences in Teheran and Tripoli marked a turning point in Arab policies. Fearing the worst, the Commission drew up plans for stockpiling oil and coal. Research and development programmes for new energy sources and a plan for cooperation with the OPEC nations. The proposals were filed away when the Council refused to discuss them.

In 1973 when the crunch came, the Nine scattered; again the oil crisis was avoided on meeting agendas, and there

was even a proposal that the Commission should be gagged and prevented from making any more proposals in case they compromised individual member states' back-door efforts to suck up to the oil exporters. So much for the Euro-Arab entente.

Meanwhile, the Dutch were left to stew in their own liberal juice. They were bailed out not by their old friends, the British or their Community fellows, but by the big multinational oil companies. The giants filled the vacuum, pumped oil into Holland's bunkers—and incidentally left the Dutch with the biggest oil stocks in the EEC and their pride intact.

The Commission is clearly embarrassed by the speed with which eight members of the Community jumped at the chance of signing up with the International Energy Agency, even though the Community was told as early as 1970 that the US would be unable to come to the rescue of the EEC in the event of a crisis after 1975. The Commission is also busy trying to put down the more damaging clichés mouthed regularly by anti-marketeers who spend most of their time unpicking the seams of the EEC.

For example, total Community budget for 1975 is £2500 million—but the cost to member states is still only 0·5 to 1 per cent of total national budgets. The cost of running the Commission is another popular aunt sally. But, as Borschette points out, 1200 of the 3000 highest paid staff are translators and interpreters. It was not the Commission that insisted on six official languages. But the key misconception is that the Commission has the power to take political decisons. It has some minor powers, but its basic job is that of a civil service. In the end when things go wrong, the politicians must carry back the can.

As Commissioners Borschette, Ortoli, Cheysson and others have pointed out, if the politicians do not start to show a measure of political goodwill and stop looking over their shoulders, the Nine will be scattered by the economic whirlwind. *Christopher Parkes*

Paris notebook

Symbol in trouble

When Brigitte Bardot began to climb the golden stairway of film business to international fame she boasted that she earned more foreign currency for France than the automobile industry. It was, of course, an idle boast and she probably knew it but it sounded good.

Be that as it may the French automobile industry has, in common with the industry in other countries, taken a severe bashing. It looks as if about 20 per cent fewer cars are being bought at home and exports are down by 12 per cent. Although this did not come as a surprise the most agonising failure was that of Citroen. With a deficit around £80 million it looked as if there was no hope and no future; a simple burial would be the best solution. But shifting a vast army of workers, well over 50 000, from the assembly line to the bread line would have been an invitation to revolution so some other solution had to be found.

Naturally the government came up with the only one possible, a loan of £10 million to permit Citroen's rival, Peugeot, to take over and rescue Citroen which, in any case, had already been taken over by Michelin tyres. André Citroen lost the business to Michelin years ago. He actually died in poverty.

Citroen cars have always been in the news. For one thing, looking completely different from other cars, they dazzle the eye; but the company has been in financial trouble for years. At one time even Michelin tried to rope in Umberto Agnelli, the boss of Fiat to help with a dramatic rescue, but the government wanted no foreigners messing around France's most elegant car and instead came up with more loans. However, the real answer fell with the force of a mallet when the last rescue operation was announced. Michelin, like Citroen and millions of Frenchmen who worship cars (at one time seven out of every 10 families owned a car), was so dazzled by the car's own brilliance that the hard core of business was overlooked. The technical staff never even sent or received a memo from the commercial staff with the result that the DS, like a godhead, was more a subject of worship than an earner of hard cash.

All government cars are and always have been Citroens even though Renault is the nationalised company. Indeed it was Renault who did the real business, for years selling over 50 per cent of production abroad. The Citroen slice of the market fell from 30 per cent to 18 per cent despite the popularity of the 2CV designed 35 years ago. Some said it looked a sardine tin but it was ridiculously cheap. Indeed it was the 2CV which led many Frenchmen later to turn to the Renault 4.

Frenchmen have always looked on their cars not so much as vehicles to travel from one place to another but rather as symbols of what they call "standing." Not to own a car, at least before the crisis, was an almost unforgivable omission. Soon after the war when Renault laid its "egg"—the 4CV which strangely resembled an egg—many families preferred to live crowded in a single room than give up the idea of owning a Renault and living in a three room flat. If they could not have both, the car came first.

The cheap 2CV was always a starter. The lowly paid began with it and their status grew as, gradually, they bought more costly vehicles. And with the roads crowded and fatal accidents mounting grimly they defended their right regardless of the consequences. The rising cost of petrol was no deterrent, the death toll no warning, the time wasted in traffic jams no profligacy; to take the Metro was an insult to dignity.

And even today when asked what restrictions should be imposed in order to beat the oil crisis, the only suggestion which meets public favour is that parking in the centre of cities should be banned. For the rest; higher priced petrol, no motoring on Sundays and reduced speed limits—none is acceptable, crisis or no crisis.

Still the hard twist of economic truth looks like making itself felt, for if an average of five out of every 200 families previously bought a new car each year it is now evident that a few are at least aware of what is happening. As for Peugeot, the company has announced that the Citroen models of the future will retain their elegance but with modifications which seems to be a polite way of writing "fini" to outstanding symbolism.

Needless to say the socialists wanted Citroen to be taken over by the state-owned Renault company but President Giscard d'Estaing is no socialist. He felt that France should have two competing groups, the privately owned Peugeot-Citroen on the one hand and Renault on the other. But Renault would have welcomed the gift and said so.

However, if the final decision failed to live up to the patriotism of the Left it did help to retain another symbol, free competition in the French car industry.
Henry Kahn

Venture

Gd Bsnss

"Venture is a fortnightly profile of a business and the man who runs it", I explained. "There are 3 of us, all =" said Toby Churchill silently. He writes his conversation on a "Lightwriter", which is an invention that he, and three others developed. He became paralysed and speechless when he fell ill in 1967. He has the use of his left arm and a few other muscles, but is bound to a wheelchair. How was he affected at first? "Confused. I had found the strength to climb out of the hole, before I really knew I was in it. An automatic process."

Churchill's first problem was to get around. He adapted his car to be driven entirely with one hand. At home he could converse, after a fashion, using an electric typewriter." But it was very awkward. The type platen and keys prevent people seeing what you write. They need to look over your shoulder, and the type is too small for any general conversation. Also a typewriter leaves a permanent record. Many stroke victims refuse to bring themselves out, if a record exists of their confused attempts." Pointing at letters on a card is very cheap but few people can take in words

 H T   W Y
T A   A

When he was mobile, Churchill needed to talk, and nothing was available that would help him. He has a degree in Mechanical Engineering. He could see

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that a moving display of the words that he typed was feasible. So he decided to teach himself electronics. He could draw with his good hand, and learned to solder using his mouth.

At about that time a group of lecturers in the Engineering Department of the University of Cambridge heard about his needs. He had already worked out how to make a light, battery-operated device with letters half an inch high. In three weeks the group made a working prototype—a job for which he had been quoted up to £20 000. He went to a camp for the disabled with it. For the first time in four years he could join in conversations, make interjections, crack jokes.

I talked to one of the team, Harry Lowe. Why not a more portable device? "Spastics don't want anything smaller. They have trouble enough using a keyboard. They will often hit two keys. With our keyboard you touch a microswitch through a shallow hole." This prevents any chance of double keying. Lowe explained that the cost of components is £300, and half of this is the cost of the display. So the whole machine has to sell for £600. The Health Service may let people buy the Lightwriter on prescription when there is a final production model.

Meanwhile, cash has been short ever since Toby Churchill Ltd was founded with £2500 provided by the family. He cannot afford to borrow money at present rates either. The team has hand-built a pre-production run of 15 machines, all of which have been sold. Noone yet can draw any income while growth consumes so much. I asked Churchill when he expects to finalise the first version of the machine. The machine flickered back at me: "In June we hope to put the first batch of 25 on the market. We doubt if we will have much trouble selling the production runs, and we anticipate further expanding batches in geometric progression. There will be occasional production problems but the main development of the basic unit will be over by the summer. We will then develop the telephone adaptor, and another development: the deskwriter, a huge lightwriter for use in ESN schools."

"Is there any hope of cutting the price drastically?"

"We'd like to, but unless we get into really large numbers, over 1000, we can't." How many are needed? Churchill has no idea, except that it is certainly hundreds and maybe thousands. How about switching to a cathode ray tube for the display? "The drive electronics are very expensive, and there's a problem of depth too." Until flat screen TV tubes are available the unit could hardly sit on someone's knee like a large lightbook.

How do people cope when he first meets them in the street or in a shop? "About 90% see the wrds apprng, read them, nd treat it as the mst ntrl thng in th world. About 10% say "That's interesting/clever" or "You're OK then, are you?" and walk off. One suspects unable to read"—deep rumbles of laughter at the thought of this conflict of disabilities.

"Do you mind if I use your abbreviations? It might help the reader to see what this sort of talking is like?"

"Genrl rul is omt vowls as mny as poss."

"How about the business strategy side; are you interested in that too?"

"Vry. We gathr once a wk hre nd tlk abt dvlpmnts, plans, etc."

"How do you feel about growth?"

"We are getting along fine. We could get along even finer if we had some labour. We don't want to do this for 3 reasons: (1) Cost, (2) because it ceases to be totally our machine, (3) because getting someone to do something is rarely satisfactory, it takes almost as long to explain something as to do it oneself. One feels guilty abt nagging others, not abt nggng oneself."

I asked if he would be interested to talk to a friend who often designs very cheap electronic items. "My only reservation is that more talks mean less progress. Otherwise, no objections."

"Do you get much social life?"

"I hv lttl tme fr gng out which means whn I do I appreciate it."

It is disorienting to talk to a lightwritist at first. Try to rewrite the transcrip with only the answers "Yes" and "No." That's the alternative.

Tim Eiloart

Pig-ignorant

About Decline and Fall

Pig has recently and ignorantly begun reading Gibbon's Decline and Fall of the Roman Empire, a project which is rather like setting out for Samarkand on foot. E. M. Forster considers it one of the three greatest works in the English language, and in reading each page one is conscious that one will never read it again for the first time. It has the most marvellous breadth and sweep: by p 188 (Everyman edition, volume 1) when Gibbon is just getting into his stride, he writes: "Since Romulus, with a small band of shepherds and outlaws, fortified himself on the hills near the Tiber, *ten centuries had already elapsed*." That "already" is breathtaking. However, diligent as always in the service of our readers, we would not waste their time in indicating purely literary glories. Decline and Fall is not only a grand and beautiful work, it is also a very pertinent one to the present times. We may flatter ourselves that technology elevates us to a plateau which has nothing in common with preceding ages, but by whatever means government is carried on, it still consists of the unification of human effort. Today's governments are as vulnerable to sedition and faction as the Romans, and take the same steps to repress them. The interest of the Roman example lies in its demonstration of what happens when one arm of the state becomes overwhelmingly more powerful than any of the others. The foundation of the Roman Empire was their new form of military organisation. All their enemies fought as individuals in a crowd; they "poured forth their souls on the first onset, they knew not how to rally or retire.' The legionaries, disciplined automata, fought like a machine; feinted, gave way, and punched back to destroy their adversaries.

The discipline, armour and auxiliaries of the legions made them unstoppable by anyone outside or *inside the empire*. As soon as the Senate, seduced by the luxury the legions had won for its members, relaxed its hold on the military command, the real seat of power passed to the soldiers. For years at a time they habitually murdered the old emperor and made a new one of the highest bidder. To pay their fee, each new emperor had to ravage his dominions. At the same time, since the legions often appointed two emperors at once, there was almost incessant civil war. None of these things was very conducive to life, liberty or happiness. Which brings us aptly to the point of this piece. The American Presidency seems an office as tossed on the waves of power and interest as ever that of Emperor, and the chances of dying honourably in one's bed not much better. Who, then, are the modern legions? Is it too fanciful to draw a comparison between the Praetorian Guards and the secret services—the CIAs, the MI6s—organisations which, in almost every modern country are licensed to operate unchecked and often unsupervised? International politics has always been a dirty business of bribery, betrayal and murder, and for instance, there are many parallels between America's handling of South America, described in Philip Agee's newly published CIA Diary (Penguin), and Rome's handling of the half savage tribes on her frontiers. Nations have always conducted their foreign affairs like this. But where we stand in danger is in the autonomy of these organs, and the lack of any rival which can hold their power in check.

The most powerful organ in a state eventually, inevitably, becomes the state. The impending senatorial investigation of the CIA, which promises to be a great deal more stringent than the Rockefeller operation, is not just a lot of reactionary old American politicians doing the liberals a favour. It is a fight to decide who rules America; and the answer to that question will decide, in the end, who rules us.

Peter Laurie

A groundling's notebook

Tania and the geranium

Yes—it's true—plants *do* respond to being chatted up. They are intelligent, sentient beings just like the rest of us (or some of us, anyhow). They feel sadness and joy, apprehension and contentment. The proof is contained in a paper appearing in the first issue of a brand new international journal called Psychoenergetic Systems. The report is entitled "Preliminary Experiments in Person-to-plant Communications", and it's by V. N. Pushkin, the well-known pedagogue, writing from the Academy of

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Pedagogical Sciences in Moscow.

I'm particularly glad that scientific evidence for the widespread belief in the anthropoid qualities of peas, pansies and petunias has arrived on my desk at this time. The ridiculously mild winter has persuaded a whole regiment of daffodils, tulips, crocuses and flowering cherry trees to bud and bloom in my garden, weeks before their time, under the foolish impression that spring is here and winter done. I have spent hours since the year began walking round the flower beds and talking to the precocious creatures, earnestly counselling them to restrain their impetuous growth, and warning them of the frosts and gales in store, but to no avail. They have continued to sprout and burgeon, unfolding and exposing tender tissues to certain destruction by the bitter elements of February and March. I had begun to believe that the stories of plant intelligence were all my eye and Betty Martin, and that the moronic organisms had neither heard or understood a word of my advice. Now, thanks to V. N. Pushkin, I know that they actually knew perfectly well what I was on about, and that their refusal to heed my pleas was due to simple pigheadedness. So when they cop it, and are lying all bedraggled and shrivelled in the winter mud, and whimpering for sympathy, I shall be able to sneer at them, and say "I told you so".

Comrade Pushkin starts off his report by recalling the astonishing discovery in 1968, made by a certain Clive Backster in the USA, that "plants could sometimes testify to the death of another living organism". According to Pushkin

> Backster placed a shrimp in a small plate above a vessel containing boiling water. The plate was tipped at a moment unknown even to the experimenter, the shrimp fell into the boiling water, and was killed. On the recording strip of a lie detector to which a leaf of a plant was attached, a pen traced the plant's reaction with ink. Repeatedly, the reaction of the plant leaf seemed to change at the moment of the shrimp's death.

But comrade Pushkin is far too gentle a soul to boil shrimps alive, or perhaps he is just aware of the fact that research ought to be and can be fun. At any rate, instead of being beastly to innocent and rather boring shrimps, he and his colleague, V. M. Fetisov, launched themselves on a further series of experiments using an attractive girl called Tanya. They also used "an ordinary geranium". The geranium had one leaf hooked to a polygraph "usually used for the study of electrical phenomena in humans". Pushkin explains that "the leaf was not plucked from the plant as we felt the entire plant would react".

Having bugged the geranium they had Tanya hypnotised, in order (so they claim) to be able to stir her to "strong emotions on command". She sat in a chair 80 centimetres from the flower.

> In the first series of experiments, the hypnotist told Tanya that she was very pretty. A joyful smile appeared on her face. She was noticeably pleased at the attention of those around her. A reaction from the plant was registered; the pen traced a wavy line on the chart.

Later they put other ideas into Tanya's head, some of them nice and some of them nasty, including the cruel suggestions that "a strong cold wind had suddenly entered the room", or that "an evil person" was approaching. Each time Tanya's emotions were stirred the polygraph pen "traced a wavy line on the chart". Tanya was asked to choose a number between one and ten, and the clever geranium showed its excitement when Pushkin and his mates mentioned the number in the lady's mind.

I am now eagerly awaiting a report from the pedagogical academy about an aspidistra capable of bending spoons.

Donald Gould

The last word on . . .

Lachrymatory litigation

Beachcomber would have relished the report that Mr Justice Ackner, in the course of hearing a case involving onion-peeling machines, transported his court for on-the-spot investigations to a Welsh-onion-pickling factory housed in a former tin-plating works built in 1880 at Burry Port, near Llanelli, and watched weeping Welsh maidens peeling 120 odoriferous bulbs a minute.

However the legal process about the industrial-size machines may eventuate, those concerned with their design might profitably consider whether there is not another multi-million pounds market awaiting a miniaturised version suitable for the domestic kitchen and equipped with effluvium suppressors permitting the denudation of allium cepa without the danger of drowning in the deluge of your own tears. Such device would be particularly welcomed by the eyeballs of housebroken husbands, since sociological research down our street indicates that most wives who are masters in their own homes follow the practice of mine, and make their spouses peel the onions when cordon bleu demands them in quantity. Especially when, for such as coq au vin or boeuf a la bourguinonne, the recipes demand baskets of those optically vicious button-onions whose one ambition is to provide lachrymatory accommodation for arks.

Such reflex, non-emotional weeping is technically described as reaction to a variety of external stimuli, such as irritation of the cornea, bright lights, sneezing, yawning and the application to the tongue of such incendiary viands as Vindaloo. While the avoidance of such hazards is recommended in general, science doesn't seem to have brought into my ken a practical protection against exuding niagaras of reflex tears while stripping down allium cepa for the epicurean pot. It has been mentioned that severing of the sensory root of the trigeminal nerve (fifth cranial) will prevent all reflex weeping. And that application of cocaine to the surface of the eye paralyses the sensory nerve endings and brings about similar ocular dessication. Unfortunately, resort to surgery is beyond both my pocket and my courage, and I couldn't face the legal complications if, when the police should catch me dusting snow about my nostrils, all I could say under interrogation was that I was just putting it on my pupils to stop myself crying while I was peeling onions.

Housewife's folk-lore could only offer the idea that if you hold a piece of dry bread between your teeth while peeling, you will not pipe your eyes in the process. But when I tried this trick indoors, the damp lamentations flowed copiously enough for a couple of wakes. When I went out into the garden to check if fresh air might help, our territorial bluetits thought I was standing in for the bird-table and essayed to whip the crust from my tear-drenched lips. When crows started gathering mistily along the clothes-line, I remembered Hitchcock and beat it back indoors. I once tried doing the onions by sense of feel with my eyes shut, but I only succeeded thereby in topping and tailing my fingers as well, and my wife protested that she wasn't cooking for cannibal consumption. Someone recommended peeling under water but the slipperiness and buoyancy of the bulbs again rendered the washing-up bowl incarnadine. So, pending the introduction of that kitchen-size, 120 a minute, anti-weeping machine, if Mr Justice Ackner, during his next six and a half months of judicial labour, should pick up any surefire hints on how to peel onions without blubbing out all over, I'd be grateful if he'd drop me an honourable line.

Patrick Ryan

Tantalizer

No 385 The Masked Mauler

Hokum Fair bids all comers fight a bout with the Masked Mauler, starting this Sunday. £1 to the winner. Or brave souls can undertake to fight the fellow on four consecutive nights and win £10, if successful on three consecutive nights. Those trying for £10 must fight only those four bouts and will win £10 or nothing at all. The fair closes next Saturday.

Nevertheless, young Jim Hawkins is proposing to risk it. A little bird has told him that the Masked Mauler is in truth three bruisers, of whom Artful Alf (the weakest) will perform on Sunday and Wednesday, Battling Bertie (the toughest) on Monday and Thursday and Cauliflower Charlie on Tuesday, Friday and Saturday.

Which four nights do you suggest that Jim has his go?

Martin Hollis

Solution to Tantalizer No 384

Twice two is eight

179 × 179 = 32 041

As EIGHT has five digits, T =1 or 2 or 3. No square ends in 2 or 3. So T = 1 and O = 9. 189 × 189 = 35 721 but this would make G greater than H.

Review

Powers of evolution

by Professor Cyril Darlington FRS

Charles Darwin: Thomas Henry Huxley: Autobiographies
edited by Gavin de Beer
Oxford University Press, pp 124, £3·30

Towards the end of his life Darwin was asked by a German publisher to provide him with some biographical information. Darwin set to work accordingly but soon found, as he warmed to the task, that what he was writing could be shown only to his family—fortunately a large one. It was all right to include thumb nail sketches of the venerable Humboldt or the eccentric Robert Brown. There was no harm in candidly discussing Babbage and Herschel, Carlyle and Macaulay; they were all dead. But when it came to Herbert Spencer, who was still alive and whom Darwin thoroughly disliked, it was another matter. And then there was the crazy Captain FitzRoy: "The difficulty of living on good terms with a Captain of a Man of War", he writes, "is much increased by its being almost mutinous to answer him, as one would anyone else."

Passages of this kind Frank Darwin had to cut out when he published part of the Autobiography five years after Darwin's death. By collating the versions I have found that they are the brightest gems in the book. They should therefore have been marked, for Darwin's sake, in the present edition. But there was something worse than this. Obviously Darwin had found Victorian piety increasingly hard to bear. Now at last he had his chance to say what he thought about it. Tucked away in the middle of his innocent story is the seven page statement of his Religious Belief: "I can indeed hardly see how anyone ought to wish Christianity to be true; for if so the plain language of the text seems to show that the men who do not believe, and this would include my Father, Brother and almost all my best friends, will be everlastingly punished. And this is a damnable doctrine."

Mrs Darwin had been brought up as a Unitarian. Even so this was too much for her to swallow. Out it went. So it was only in 1958 that the unexpurgated autobiography could be released to the world with all the best bits restored by their granddaughter, Nora Barlow. Side by side with it now appear some autobiographical notes of T. H. Huxley. The enterprise of joining the two men's work proves to be well worthwhile. Here we see them compactly presented with very few frills for the first time.

How little the two had in common! We may agree with the editor that neither had had any systematic instruction in biology at all. This is an advantage in most fields where original inquiry is needed. They both detested school which is again something highly compatible with originality. They were also both greatly honoured in their time since Darwin was buried in Westminster Abbey and Huxley made a Privy Councillor. Beyond these accidental details the contrast was profound. Darwin found writing irksome but was compelled to write in order to expound his ideas. Huxley loved writing and wrote a good deal too much. Darwin's keen observation of people makes his autobiography of profound historical interest whereas Huxley obviously had nothing comparable to say: for once he was tongue-tied. Darwin was highly unselfconscious: he destroyed all his letters before 1862. Huxley was supremely self-conscious, whence his addiction to fierce polemics. The one had humour without wit; the other had wit without humour.

What was the essential contrast between the two men's attitudes to knowledge and discovery? If I am to put it in one phrase I would say that Darwin was concerned with how evolution had happened while Huxley was concerned with the wonderful scheme that resulted. Darwin was consistently and indefatigably inductive. Huxley was never anything but deductive. To be sure he delighted to demolish the deductive plan of divine purpose. But he replaced it with an equally deductive plan derived from Darwinian evolution for explaining comparative anatomy.

The contrast between these two attitudes of mind left its mark on the history of biology. For after Darwin's death it was comparative and always descriptive anatomy, morphology and systematics which held the field. It was Huxley's facile approach, which appeared to be Darwinian, but which in fact choked Darwinism in the 20 years after Darwin's death. And of course Mendelism and genetics as well.

This book is indeed admirably produced and beautifully illustrated with 12 plates showing the *dramatis personae.* There we can see the features of that malignant mandarin, Sir Richard Owen, and of the bumptious bishop, soapy Sam Wilberforce. It is a pity, though, that the two outstanding photographs, the ragged old Huxley and the dandyish young Darwin, are relegated to the destructible dust cover.

Cyril Darlington is emeritus professor of botany at the University of Oxford

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Oil
The biggest business
by Christopher Tugendhat and Adrian Hamilton
Eyre Methuen, pp 404, £6·25

Oil has been stealing the headlines regularly for some time now and there is no sign of the furore abating yet as the news switches from the Middle East to the North Sea, across to the United States and back again. Anyone trying to maintain some understanding of what is going on will welcome the new edition of Oil: The Biggest Business.

The book is divided into two parts: in the first part Christopher Tugendhat, MP and well known oil industry commentator, traces the beginning of the industry, the rise of the oil "barons", such as Rockefeller, and the role of oil in the Second World War through to the formation of OPEC in 1960. The clear and concise style of Tugendhat's interesting account was well received when first published and this recommendation still stands.

In the second part of the book Adrian Hamilton, who has built up a respected reputation as the Financial Times specialist reporter on oil, picks up the story from the point where the oil companies and western consumers went from strength to strength on the back of cheap Middle East oil in the early 1960s.

The question of the "energy crisis" is tackled thoughtfully—the consumer is not allowed to escape his liability. The long term ability of the consumer to save on oil is questioned. We are reminded of the natural tendency to revert to more wasteful ways once the immediate crisis is past. "The day of reckoning may simply be put off for a time rather than avoided altogether."

On the power of the oil producing countries Hamilton points out that with Canada, Australia, Norway and Britain putting their national need first, the producers will take some persuading to act differently. At the same time, the judgement of the international oil companies does not go unquestioned and, in this context, the chapter dealing with the recent Middle East price talks makes fascinating, if somewhat disturbing reading.

On the question of the search for new oil, we are told that some three quarters of the world reserves are accounted for by only 200-odd fields. Is there a warning here for Britain's North Sea programme?

Surprisingly, bearing in mind that Hamilton has established a dominating lead in the coverage of North Sea oil affairs through his columns in the Financial Times, this area is not given special prominence in this book. But this is only a minor criticism. And the book is after all on the international role of the industry. It is stressed that even in its modern shape—shorn of some of its former power and glamour—the oil industry remains international and it really is big business. Who else but Exxon could spend $100 million on choosing its name? Backing up the text are useful and clear statistics and interesting contrasting illustrations.

All in all, two authoritative oil writers have joined forces to produce a book which will be compulsory reading for all those involved in oil. *Clive Callow*

Type A behavior and your heart

by Meyer Friedman and
Ray H. Rosenman
Wildwood House, pp 276,
hardback £4·95, paperback £2·75

If titles sell books, the authors of Type A Behavior and Your Heart are unlikely to be able to retire on their royalties.

Drs Friedman and Rosenman are two American cardiologists who fervently believe that coronary heart disease, which is ahead of cancer as the biggest single slayer of Western Man, is primarily caused not by gluttony and a diet of eggs and butter and other victuals oozing out cholesterol, or by sloth and a working life spent crouched over an office desk, or even by an addiction to cancer sticks. They admit that all these things, and a variety of other factors (such as choosing the wrong parents) may increase the chances of the coronary vessels which supply the muscle of the heart with blood becoming clogged, but they are firmly convinced that none of these dangerous circumstances is likely to do fatal damage except when allied to a particular attitude of mind.

There are, in their catalogue, two kinds of people. There are Type A people, who are thrusting, ambitious, self-critical, and compulsive fillers of the unforgiving minute. And there are Type B people who are relaxed, content with their station in life and often happy just to stand and stare.

Drs F and R believe that the emotions which chase themselves endlessly around the minds of Type A citizens are responsible for firing off nerve impulses and for stimulating the secretion of hormones, which together produce a pattern of biochemical activity in the body of a kind heavily favouring the furring-up of coronary arteries, and the formation of the clot which finally blocks the blood supply to a patch of heart muscle, and too often kills. Hence their unrevealing and untitillating title—Type A Behavior and Your Heart.

A good deal of evidence supports the idea that emotional stress is a major cause of coronary trouble, including the authors' own discovery that American accountants have a much higher blood cholesterol level around mid-April when tax returns are due, and the fact that city dwellers suffer coronary heart attacks three times more frequently than countrymen, and that London bus drivers are coronary victims twice as often as their conductors.

Last year a British physician, Malcolm Carruthers, published a book called The Western Way of Death (Davis-Poynter) which also spelt out the manner in which emotional stress produces changes in the body chemistry of a kind likely to damage coronary vessels, but he took the argument further than Friedman and Rosenman have done. He pointed out that the fats and sugars and hormones poured out into the blood in the face of an emergency would, in cave-man days, have been used to support a vigorous physical response—either fight or flight—and would have been consumed in the process. But contemporary threats to our security and interests, such as HM Inspectors of Taxes, can rarely be met by muscle-power. So the products of the alarm reaction stay in our blood and do their damage. The Type A people of Friedman and Rosenman are the sort who in an earlier age would have been chiefs and conquerors. The Type B citizens would have hidden in their caves whenever things got rough.

Friedman and Rosenman devote the last half of their text to telling Type A leopards how to change their spots, and how to find their satisfaction in such physiologically safe pursuits as prayer and cultivating roses. Malcolm Carruthers also sees temperance as the prescription for long life, but wants it coupled with a healthy physical activity.

But Sir Peter Medawar, who wrote the introduction puts the whole thing in perspective. He says "Even if Type A's lead shorter lives they live much more life while they are living it."

Carry on smokin'.

Donald Gould

A guide to the food regulations in the United Kingdom

by Diana M. Amor
British Food Manufacturing Industries Research Association, Leatherhead, Surrey, pp 184, £17·50 to non-members, £7·50 to members

That juicy orange fresh from the greengrocer may contain preservatives, antioxidants, and mineral hydrocarbons (eg paraffin), without any form of labelling being required. On the other hand, it must be its natural colour—orange skins cannot be dyed to make them look better, as they can in the US where a carcinogenic dye is permitted especially for this purpose.

No doubt the food producers will write in to say that the preservatives and the like are all needed to get us fresh fruit at all, which may well be true. But that does not explain the need for a vast list of approved food colourings, some of which are now being called into question (see Feedback, 2 January, p 29). Nor the fact that there are no restrictions at all on flavourings.

At a time when many of the things which get dumped into processed (and fresh) food are coming into question, this guide provides a very useful reference as to just what the rules are which are supposed to protect the consumer.

In addition, the book tells just how much food manufacturers are permitted to lie. For example, meat pies need be only 25 per cent meat, meat and vegetable pies (and Cornish pasties) need only have 12½ per cent meat, and vegetable and meat pies have no minimum meat requirement at all.

Sausages, on the other hand, must be half meat (although in beef sausages, only half the meat need actually be beef). But unlike meat pies, the meat content requirements do not apply to sausages sold to caterers. Sausages with less than half meat should not actually be sold to customers, but Diana Amor offers publicans and other caterers the reassurance that "from a practical point of view once such products have been cooked it is difficult to determine accurately their original meat content, although the caterer is in fact breaking the law in selling such substandard products."

Fish cakes need only be 35 per cent fish, and there is no fish minimum at all for fish fingers. And so on.

But it is nice to know that one food is better than advertised. Double cream would be more accurately described as triple cream (or 2·7 cream)—double cream must contain 48 per cent milk fat, compared with 18 per cent for single cream. *Joseph Hanlon*

Exploring data analysis

The computer revolution in statistics
edited by W. J. Dixon and W. L. Nicholson
University of California Press, pp 410,
£7·00

This book emerged from a "workshop" conference set up to examine the frontiers of data analysis based on computer use, held in Los Angeles in 1971. The participants contributed a data-set and its analysis (there are in all eight such case-studies); these contributions, together with the comments of other participants, make up the eight chapters of the book. Half these are concerned with the life sciences (breast cancer, electro-encephalography, soil fertility, responses of the brain to abrupt changes in an audio signal), one chapter is concerned with social science (block-voting practices in UNO) and one with physical science (rainfall and microwave radio), while the remaining two are primarily methodological (robustness of location estimates, probability-density estimation). The editors propose as a definition of data-analysis: "the application of one or more techniques to a set of data steered by the problem". (It is the "application" which is to be "steered".) This may or may not be found helpful; one recalls the valuable time pointlessly wasted in early attempts to "define" operational research, and one hopes that the cycle is not about to commence afresh.

The contributions are uneven in quality, and some, in opinions expressed by participants, do not "qualify" as "data-analyses". A steady reading of the whole book is none the less a worthwhile experience because considerable problem-background is given, and in nearly all cases we are supplied with the complete data-set, and so are tempted to devise alternative treatments (to be carried out by our pupils).

J. A. Hartigan (Yale), writing on the voting by 126 nations on 50 UNO resolutions in 1968, describes an interesting technique for extracting a special kind of information from (eg) zero-one matrices. He asks the question, can we pick out paired groups (A, B) of countries and resolutions such that each country in group A votes in much the same way as the other members of A on each single resolution in group B? He describes (not very clearly) an algorithm which is designed to deal with this problem, and applies it to the data to get the sort of "blocking" among states and resolutions that we might expect. The excitement comes later, in the discussion on the paper by J. W. Tukey (Princeton), whose data-set records the "variability" in the performance of each one of 65 "location estimators" when tested on "samples" of individual size 20 from 18 different "statistical situations" (some gaussian, some contaminated gaussian, some Cauchy, etc). Tukey's analysis is complex, and rather difficult to read. Hartigan points out that his own "blocking" algorithm mentioned above can be adapted to deal with this problem in an intuitively appealing way; one then finds oneself looking for a group of estimators (A) and a group of situations (B) such that each estimator in the group A has a common pattern of behaviour (varying from situation to situation) across the group B. When one sees *both* these examples of Hartigan's technique one grasps the essentials of a new methodology, and at the same time one understands each application the better through comparison and contrast with the other. To use a phrase of which Tukey is very fond, one can "borrow strength" by watching a technique at work on several problems, where some of the data-sets (as here) may be real and some "simulated". This seems to indicate that the definition of data analysis proposed by the editors is too narrow to do full justice to the subject.

Several of the case-studies are concerned with multivariate data where a single "observation" is "functional" in form: a moving rainstorm (A. Jaeckel and J. D. Gabbe, Bell Telephones), EEG spectra (M. R. Mickey, Los Angeles), audio-stimulated EEG activity (D. C. Martin and H. L. Lucas, Washington and North Carolina); these are especially interesting. A methodological study of the same general character occupies the last chapter, in which R. A. Kronmal (Seattle) and M. Tarter (Berkeley) present an account of their particular type of Rosenblatt kernel-estimator for one (and two)—dimensional probability density curves (and surfaces); it is interesting to compare this work, and its application to both real and simulated data-sets, with the quite different spline-based study by Liliana Boneva *et al.* (J. Royal Statist. Soc. (B) 33, 1971, ppl-70). The latter techniques can now readily be applied to these and similar data-sets using Fortran programs recently made available in Tech. Report CC-7401 of the Computer Centre, University of Newcastle, New South Wales. "Exploring data analysis", using programs such as these, and the valuable data sets presented in this book, is now within the reach of all those who possess the requisite computing facilities. *David Kendall FRS*

Single cell protein

edited by P. Davis
Academic Press, pp 280, £5·60

Anyone looking for a readable international survey of the principles, problems, and potentialities of microbial fodder and food will find it here. The proceedings of a symposium held in Rome by Liquichimica S.p.A. and Stanford Research Institute, the volume reflects single-cell protein developments throughout the world. Quite rightly, toxicological and safety aspects of the subject are emphasised, though to the neglect of the social and political implications. While the book fortunately lacks much of that naive and insensitive advocacy often shown by microbial food enthusiasts, most of the contributors are in little doubt of the massive potential of SCP. They do not for the most part consider how their novel technology should fit into the wider pattern of conventional agriculture.

A much more serious failing of the book, not uncommon with symposia, stems from the long delay in publication. The Rome conference was held at the beginning of November 1973. That was before the oil sheikhs had really shaken the world, and when dizzy calculations about the gargantuan quantities of cheap food available by growing microbes in petroleum were still acceptable. The recent survey by Martin Sherwood (New Scientist, vol 64, p 634) provides a more judicious assessment of the present-day position. Included as appendices in the book are the three guidelines issued by the UN Protein Advisory Group for evaluating novel sources of protein—two of which have also since been modified.

Emphasising these demerits, it is indeed a pity that a book which is published in 1975, should begin with a foreword theorising about what may happen in the middle of 1974.

In such a fast-moving field, Academic Press should be able to do better than this. *Bernard Dixon*

Handbook of marine science

edited by F. G. Walton Smith
CRC Press, pp 628

The eminent Norwegian oceanographer H. U. Sverdrup defined oceanography as the "application of all sciences to the study of the sea". Even in these times of specialisation, the oceanographer is more likely than most scientists to be involved in more than one discipline. This is the justification for preparing a special handbook of constants, tables, and properties covering all of the major disciplines as they relate to the ocean.

This first volume covers chemical oceanography, physical oceanography, atmospheric science (relation between ocean and atmosphere), marine geology, ocean engineering, and a number of other tables of conversions and constants most used by oceanographers. Subsequent volumes will be concerned with biological and fisheries data.

Of course, many reference handbooks already exist for the basic disciplines, and

An open letter from Sir Bernard Lovell OBE FRS, President of the British Association for the Advancement of Science

Dear Colleague

As President of the British Association I write to ask if you would become a member in order to help and strengthen the activities of the Association. As you know, the British Association was founded in 1831 to advance the cause of science. The annual meeting has been the venue for many famous occasions, such as Huxley's impassioned espousal of Darwin's theory of natural selection, the call for a moratorium on science by the Bishop of Ripon and the release of information about the prodigious discoveries in nuclear physics in the 1930's. The reaction of the Association to the economic and social crises of that period was to give more attention to the relationship between science and society and since then it has helped to maintain a link between the scientific community and society as a whole. In recent years the Association has initiated multi-disciplinary working parties to investigate the frontiers of science as they are seen to affect the structure of contemporary society—ethically, legally and socially.

For the 1975 annual meeting, which will be held at the University of Surrey in Guildford from 27 August to 3 September, events of wide interest will be arranged—such as an all-day symposium on the work of the Research Councils—in addition to the specialist discussions of the scientific sections. I hope you will complete the membership form below and that you will be able to attend the Guildford meeting.

Yours faithfully

APPLICATION FOR MEMBERSHIP

To: **Miss E. Coffey**
British Association
Fortress House
23 Savile Row
London W1X 2AA

From: ....
....
....
....
....

I enclose a cheque/draft for £3.00 payable to the British Association for the Advancement of Science.

assembling a handbook of marine science must involve elimination more than compilation. The guideline has been to choose those tables that in the experience of the editor and his advisory board are used most frequently by the oceanographer. I doubt whether any single handbook can eliminate the need to consult other handbooks from time to time, but the present one should prove valuable and, if kept close to hand, avoid many a time-consuming pursuit through the library reference sections.

Tony Loftas

Bilayer lipid membranes (BLM)

Theory and practice

by H. Ti Tien

Marcel Dekker, pp 656, $39·50

Friends of the late A. S. C. Lawrence will be delighted to read how it was through his writings on the formation of black soap films that biologists were to acquire their most useful model membrane, the BLM or bilayer lipid membrane. Surprisingly, however, Ti Tien in his book does not refer to Lawrence's classic book on soap films at all. There are other more serious omissions in this rather too facile and carelessly assimilated logbook of a decade of research. The failure, for example, to discuss Haydon's efforts at establishing the exact chemical composition of BLM's, weakens the authority of the book. Furthermore, for a book of some 600 pages and claiming to "summarise the current status of research" to overlook the important and careful work of the Cambridge workers on unit conductance phenomena, is outrageous.

The merit of the book lies in its naiveté and uninhibited optimism; nowhere in the literature can one find a guide to the first-steps of BLM preparation more innocently described, yet no mention is made of the technical problems of using picoammeters. Thus, even the "simple" experiments discussed in chapter 11 must be read with a pinch of salt (or better, valinomycin). No other publication covers so wide an area of experimental innovation, exploration and application.

The book, in essence, is most correctly described in the preface by Ti Tien as a "highly personal account of . . . his own observations' and as such should be regarded. Ti Tien after all, was one of the principal innovators of this most useful preparation.

Alec and Andrew Bangham

The path to the double helix

by Robert Olby

Macmillan, pp 510, £12·50

If the writing of a major historical treatise sets the seal on a scientific story, then the discovery of the double helix is now complete. Olby's The Path to the Double Helix is just such a book—history of the scientists, science by the historian, science for the historian.

Purely as an historical record, this book, as expected, goes into the source material in far greater detail than Jim Watson's much shorter and ethereal volume—The Double Helix. It is difficult without a comparably scholastic search to assess this aspect but it does appear to be rather strong on those phases which arose out of the personal contacts. To ascend above the ordinary the history of science should be not only well-researched but also presented lucidly and hopefully provide new perspectives. The organisation should be logical and the flow of ideas reasonable. Here, unfortunately, we have convoluted chapter headings and a disturbing lack of critical discussion. Indeed when some serious criticism of Schrödinger's What is Life is presented, it is introduced with an apology and appears strangely out of place. Everything is left to the reader's own assessment with the exception of a little glorification of a few personalities.

In his foreword Francis Crick draws attention to one of the great strengths of the book with a few of the human anecdotes which amused him. On a rough channel crossing Darlington is said to have taught Bernal "all the genetics and cytology anyone needs to know". My favourite, particularly in these troubled economic times, was the correspondence between Flexner and Levene at the Rockefeller between 1916 and 1930 concerning the former's parsimony and the latter's profligacy. In the same vein, the reply received from Mellanby, the Secretary of the Medical Research Council, by Perutz in 1948 to his request for leave of absence to visit the USA on a Rockefeller travelling fellowship is priceless. No doubt when £1 was still worth $4 we could say that the director of a MRC Unit should not only remain at his post but also be of sufficient merit to attract Americans to his laboratory rather than go and seek their help!

At £12·50 this book is by no means cheap which probably does not matter as it is not aimed at mass personal sales in the same way as Watson's book. The comprehensive nature of the research it contains ensures that it will be invaluable to future historians in this field.

Chris Bruton

Media

BBC to launch new science education series

The BBC has been doing its homework into ways in which it can contribute most usefully to secondary school science. Last week in London the wraps were off some of the videocassettes, films, filmstrips and tapes from three major series of programmes designed as resource material for 13-16-year-old pupils set on taking CSE, GCE O-level and the Scottish Certificate of Education O-Grade courses.

Through a massive nationwide survey the BBC and the School Broadcasting Council has gleaned from science masters information on the kind of material that they would like the media under the control of the BBC to produce. Clearly there is a strong case for radio and TV to provide resource material that forms the basis for classroom discussion. The aim is to provide material which is not normally accessible in the classroom, in programmes that are stimulating and flexible rather than merely course-oriented. An attempt to aid rather than to replace the teacher. Because it would not be feasible for the BBC to consider an unlimited series of TV and radio programmes, it asked science masters to put a ranking order on the topics that they want tackled.

The outcome so far is five units of radio and radiovision material (filmstrips etc to be watched during the programme) aimed at extending and updating topics for CSE and O-level schemes. Producer Arthur Vialls tackles such diverse subjects as vision, hearing, microorganisms and public health, man's impact on the countryside, and natural selection and inheritance. The technique is to use a mixture of factual sequences, descriptive dialogue from working scientists, and, when treating historical events, dramatic presentation—such as Semmelweiss trying to get across the idea of asepsis in 19th century Vienna.

For BBC School Television there are 10 20-minute programmes each on the physical and biological sciences. The Physical Science Series includes elements of the periodic table, microscopes and molecules, X-rays and radioactivity, and energy utilisation. In Mastery over Metals, for example, producer Peter Baker and consultant Professor W. Alexander vividly relate in an excellent four colour film the physical and chemical activities of metals to their everyday use. The programme material comes from a range of sources and will certainly be of wide interest.

Among the Biological Sciences there are to be programmes on cells, the kidney, the energy chain, behaviour, and artificial selection. The First Day of Life tries to show how the fertilised egg obtains the substances necessary for development. By exploiting special animations and timelapse photography producer Andrew Neal provides some splendid illustrations of development in plants, fish, amphibians and birds. The part of the programme tracing the development of the human embryo from conception to birth will provide its intended audience with an impactful experience.

The pace and superb colour of these science programmes, together with their carefully chosen dialogue, will surely elicit extensive classroom discussions. Teachers will need to prepare themselves for this, and guide notes will be available.

The Beeb is to be congratulated on this new venture, and for making available through the SBC at this early stage films and tapes of some of the programmes for groups of teachers to inspect.

While the TV series starts in autumn 1975, the radio broadcasts will not be transmitted until September 1976. Certainly this should give schools plenty of time to sort out not only their needs but also their media facilities and concomitant budgets. The BBC hopes that many schools will record these fortnightly programmes and extract from them whatever best suits their particular needs.

Richard Fifield

Letters

Swaminathan controversy

Sir,—Mr D. A. V. Fischer, writing from the International Atomic Energy Agency (Letters, vol 64, p 948), has not produced any evidence of the "several inaccurate statements" of which he accuses Dr Hanlon (Feedback, vol 64, p 436). Mr Fischer states that the average annual budget of the FAO/IAEA Division during 1966 to 1971 was less than £500 000. An official FAO document, CL 60/15, dated March 1973, contains figures provided by that division showing its annual expenditure to be about \$2·2 million or "nearly £1 million" as correctly stated by Dr Hanlon. There is documentary evidence that this level was approached around 1969/1970 and that it is still rising. On further inquiry Mr Fischer would find the expenditure of the plant breeding section to be about twice that quoted by him, or probably considerably more.

The list of mutant varieties which Mr Fischer advisedly said "perhaps" best demonstrated the value of a programme on induced mutations (which value he said I myself enunciated in 1958, but only when used "in appropriate circumstances" which I clearly defined), was published as recently as 1974 in the FAO/IAEA report cited by him. That list was included in an article by B. Sigurbjoersson and A. Micke of that division as evidence of "the achievements already made". It includes Swaminathan's Sharbati Sonora protein-lysine claims which documentary evidence quoted by Dr Hanlon shows to have been known among scientists since 1966/1967 to be non-valid. That is not the only item in that list which other scientists do not recognise as valid. That was the third presentation of that list, always including Sharbati Sonora, by those FAO/IAEA scientists at FAO/IAEA meetings since July 1969 (Induced Mutations in Plants, pp 673-698, IAEA, 1969; Induced Mutations and Plant Improvement, pp 526-544, IAEA, 1972). The value of international meetings is impaired when scientists in an international civil service repeatedly present spectacular but non-valid claims as valid. Dr Swaminathan was also present at all three of those meetings. He was also chairman of a session at another FAO/IAEA meeting in June 1970 when there was discussion of the fact that analytical figures from Dr B. O. Eggum (Denmark) showed lower protein and lysine contents in Sharbati Sonora as compared with its parent, contrary to the higher contents claimed by Dr Swaminathan (Improving plant protein by nuclear techniques, pp 289-302 and 447, IAEA, 1970). He remained silent during that discussion, although the CIMMYT data agreeing with the Danish data had been published in August 1969. Shortly before that publication I had opened discussion with Dr Swaminathan in my office in FAO in Rome on the non-validity of his data but he did not respond in any way and immediately left me. There is no excuse for long-continuing publication from the FAO/IAEA division of claims known among scientists not to be valid, because that division has always had its own analytical laboratory in Vienna costing £100 000 a year, as shown in the FAO document cited above

On 15 March 1974 Dr Swaminathan was elected a Fellow of the Royal Society, notwithstanding the publication in August 1969 of Dr Borlaug's CIMMYT data showing the extensive non-validity of Dr Swaminathan's protein and lysine data, and even after press articles on 19 January, 1973, put on record that the official report of the inquiry into the allegations arising from Dr V. H. Shah's suicide in protest against professional and administrative irregularities in science had been submitted to the authorities. That report provided evidence of continuing publication of non-valid data by Dr Swaminathan in a manner clearly contrary to the motto of the Royal Society expressing its "determination to withstand dogma and to verify all statements by an appeal to facts."

R. A. Silow

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00136 Rome

(Dr Silow was an FAO director on special assignment to the IAEA until 1968—Editor)

Sir,—As a person who has specialised on the genetics of nutritional quality of the wheat variety Sharbati Sonora, for nearly six years, I was dismayed to read Dr Hanlon's column, which is libellous and has obviously been printed because of the knowledge that it is difficult for Third World scientists to take legal action against a "First World" journal.

The allegation that "Sharbati Sonora may not be a radiation mutation at all" is naïve. Just because CIMMYT is using this variety in its crossing programme, does it become a natural mutant? It is well known that radiations increase both the frequency and spectrum of mutations. This statement could well be made of all induced mutants isolated from the time of Professor Muller. To my knowledge, in the field of mutation breeding, no mutant has been found that does not exist in nature.

Working with the variety Sharbati Sonora for about six years, I found the protein content of this variety varies from 12·2 to 20·9 per cent and lysine content from 1·8 to 2·8 per cent. Anyone conversant with the genetics of quality improvement of crop plants would know that the heritability and stability of protein and lysine content is low and to a large extent these are governed by the environment. Because of this there are several difficulties encountered in selection for quality characteristics.

However, variations in published values for nutritional quality characteristics of crop plants are not confined only to "Thirld World" science. For example, P. J. Mattern, V. A. Johnson and J. W. Schmidt of the University of Nebraska, Lincoln (see their Project Report on Improvement of Nutritional Quality of Wheat through Increased Protein Content and Improved Amino Acid Balance, 1965) reported a lysine content of 4 per cent, in wheat, with a mean of 3·59 per cent. The low repeatability of such results is indicated by the amendments of their earlier reports on a recheck and elimination of two lines from the high lysine list and one from the high protein list.

Similarly Dr R. C. Pickett and Dr D. L. Oswalt of Purdue University, Lafayette, Indiana, reported results (see their 1970 report of the project on Improvement of Nutritional Quality in Sorghum) where the same material showed a range of 14·02—20·2 per cent protein and 2·3 to 3·7 per cent lysine in one year, but in the next season at the same location the contents were reduced considerably (9·4 to 15·9 per cent for protein and 1·8 to 2·5 per cent lysine). The same group, in 1974, reported 9·0 to 13·7 per cent range in protein in the material specifically chosen for high protein content and quality. Interestingly, the same accession gave 9·6 per cent protein in Indiana and 12·1 per cent in Nebraska, while another accession gave 13·1 per cent in Indiana and 10·8 per cent in Nebraska.

At least for me these results would indicate that the environment in which a line is grown has a major influence in determining the protein content and quality. The two examples I cited should indicate to Dr Hanlon that "non-valid" science is published in the "First World" also.

Anand Kumar

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Transferring manure

Sir,—I refer to Sigurd Larsen's letter (23 January, p 23) relating to Tam Dalyell's comment (Westminster scene, 2 January, p 30) that government help in trucking manure from regions of overproduction, notably the western dairying areas, to regions of high fertiliser use, notably the arable eastern areas, would be money well spent. Dalyell's comments are sound, but the reasoning is wrong, and Larsen's argument misses the point as Dalyell misleads him.

May I bring the attention of both to an article published by myself in Environmental Pollution Management (vol 4, No 6) which outlined a least-mileage, least-cost transport system to undertake such a manure trucking operation. My model was based on the extremely successful Dutch manure bank (Stichting Brabantse Mestbank) which operates from Tilburg under the auspices of the Ministerie Van Landbouw en Visserij, Rijks Agrarische Afvalwaterdienst (their Ministry of Agriculture), and actually makes a profit. The Dutch situation is broadly similar to England's in that they have localised areas of intensive animal husbandry and areas of newly reclaimed soils badly in need of organic fertiliser.

The model I proposed trucked manure from the west of England to the east with benefit to both regions, but here Larsen misses the point; the model is not based on using the manure solely for its fertiliser nitrogen content. The objective of the model is two-fold:

1. The warm wet western areas of England are ideal for dairy operations and hence produce enormous quantities of slurry. This slurry can be, and is, spread onto grass for use as a fertiliser but there is a maximum one can use and the limitation is not its nitrogen content at all but the water content. Over-application of slurry damages pastures physically because it is too wet, and this is in addition to water pollution problems, disease risks, palatability problems, nutrient imbalance and the danger of inducing anaerobiosis in the rooting zone of the soil. Hence, slurry must either be dried for use as a fertiliser or trucked out of the area altogether. The latter solution is the cheaper.

2. The eastern counties are virtually optimally fertilised at present and this is related to the fact that fertiliser increases above a threshold level result in diminishing returns. The farmer is careful to fertilise up to this economic optimum and not beyond. The east of England, therefore, requires no more nitrogen. However, and this is a vital factor in the manure trucking model, the eastern soils are badly in need of organic bulk as a soil conditioner and not as a fertiliser. Any fertiliser nitrogen contained in the manure is an added bonus since the east will wish to apply less as synthetic nitrogen. There will, of course, be a nitrogen depletion in the west from where the manure was removed, and the savings in the east can offset this.

Thus, the model is based upon the water and organic content of manure with fertiliser nitrogen a consequential, not a key, factor.

I hope these comments help to clarify what was, on the face of it, an interesting argument by Larsen, but turns out to be unsoundly based through no fault of his own.

Stephen L. Willets

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Paranoids all

Sir,—As a fellow-paranoid, I could not help agreeing with much that Dr Dumont ("Beyond paranoia", 23 January, p 197) wrote, but I also detected a note of hypocrisy.

Any good paranoid must realise not only the pointlessness of the activities of vast bureaucracies, but also the pointlessnes of any conceivable human aim or aspiration. Why should Dr Dumont, as a psychiatrist, be able to adopt a holier-than-thou attitude to other professions, when he himself (presumably), spends his time dragging poor souls out of their so carefully-concocted escapist fantasies into the "real" world. Who is he to say that one world is better than another? Doesn't any such judgment rely on more or less arbitrary standards, depending on one's viewpoint?

What I am saying is that before he goes about knocking physicists and engineers at Cape Kennedy, Dr Dumont should perhaps examine his own motives for doing whatever it is that he does do.

Ray Norris

St Catharine's College
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Energy analysis

Sir,—A point has been raised by Mr Kenward of your staff and several correspondents (Letters, 16 January, p 160) that there should be agreed conventions in energy analysis. I see from a recent issue (Comment, 23 January, p 186) nobody has yet informed New Scientist that such conventions are well established and are embodied in the report of the workshop on Energy Analysis: Conventions and Methodology, available from the International Federation of Institutes for Advanced Study, The Nobel House, Sturegatan 14, Box 5344 S 102 46 Stockholm, Sweden, price $10.

Malcolm Slesser

Energy Analysis Unit
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CII Building
100 Montrose Street
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Sampling statistics

Sir,—Joseph Hanlon wonders (Feedback, 16 January, p 148) if the government is being misleading in its interpretation of data to justify cuts in local transport subsidy. Bending official figures is by no means new, and you may be interested in another incident of two years ago.

The wearing of crash hats by motorcyclists has been made compulsory. The back-up for this was official figuring that the probability of a motorcyclist being seriously or fatally injured was 30 times that of a car driver. (It turned out to be 26 times, "rounded up" for convenience.) The motor cycling industry commissioned Keele University to study motorcycle riding compared with mileage, and the probability turned out to be 11 times.

The official response to this finding was to discredit the Keele study by talk of "biassed sample," with but scanty information being released on how the DOE operates its sampling methods and data collection so as to avoid bias.

A. L. Minter

48 Ten Ashes Lane
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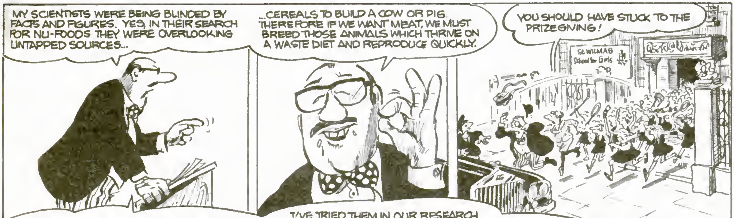
B45 8PE

Chlorophenols

Sir,—Your review of the hazards presented to the ecology by chlorophenols (Monitor, vol 64, p 908) draws attention to the dangers inherent in releasing large quantities of these substances. It may therefore be of interest to report that chlorophenols have been found to cause "taints" or "off-flavours" in many types of foods, thereby rendering large quantities of otherwise good foods uneatable.

Grimbledon Down

Bill Tidy


MY SCIENTISTS WERE BEING BLINDED BY FACTS AND FIGURES. YES, IN THEIR SEARCH FOR NU-FOODS THEY WERE OVERLOOKING UNTAPPED SOURCES...
...OF PROTEIN ALREADY EXISTING! WE ALL KNOW THAT IT TAKES UNECONOMICAL AMOUNTS OF...
...CEREALS TO BUILD A COW OR PIG. THEREFORE IF WE WANT MEAT, WE MUST BREED THOSE ANIMALS WHICH THRIVE ON A WASTE DIET AND REPRODUCE QUICKLY.
I'VE TRIED THEM IN OUR RESEARCH KITCHEN. YES, GUINEA PIGS, HAMSTERS AND RABBIT-
YOU SHOULD HAVE STUCK TO THE PRIZEGIVING!
St WILMAB School for Girls

It has been found that one of the major causes of complaints of "off-flavour" in many types of foods has been the chlorophenols. In some cases, the contamination has been found to be air-borne; in others water-borne.

A particularly interesting case is of poultry flesh contaminated by the chlorophenols derived from the wood shavings used as poultry litter. Actually, the "off-flavour" here was caused by chloroanisoles, derived from chlorophenols by microbial (fungal) methylation, a fact established in a series of papers recently published from the Food Research Institute of the Agricultural Research Council.

Another case of general interest has been that in which large quantities of high-quality biscuits have been contaminated by the absorption of air-borne chlorophenols. This was due to atmospheric pollution derived from herbicide factories, situated some five to 10 miles from the biscuit factory. This can apparently take place unchecked by any official authority.

Another source of "off-flavour" due to water-borne chlorophenols is the formation of minute traces of these compounds by the interaction of chlorine (widely and justifiably used in water treatment) with phenolic substances either present in the water supply or derived from other sources, eg pesticides, disinfectants or detergents. Some pesticides or herbicides, derived from chlorophenols, often contain some 0·5-1·0 per cent residual chlorophenols as an impurity.

A survey of our experience in this field was presented last year in lecture form to the Food Group of the Society of Chemical Industry and will shortly be published elsewhere.

I very much support the decision of the Department of the Environment to inquire further into the environmental effects of the chlorophenols.

Nathan Goldenberg

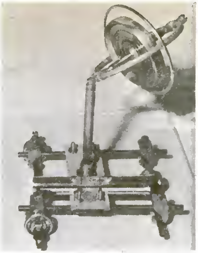
Marks & Spencer
57 Baker Street
London W1A 1DN

Laithwaite's machine

Sir,—In his Royal Institution lectures Professor Laithwaite contended that a precessing gyro did not obey Newton's laws with regard to centrifugal force, and momentum conservation. He showed that the support pillar of gyro precessing under gravity did not slide laterally due to centrifugal force although placed on ice, "to reduce friction". He had apparently not performed the simple calculation showing that, at the very slow precession rate he demonstrated, the centrifugal force was a few dynes only, and he made no attempt to prove that he had reduced friction to below this level. Had he used an air-bearing pad, or a plate supported on three steel balls—(I have!)—he would have seen the gyro and pillar rotating about their common centre of gravity—(like a binary star system)—with their centrifugal forces in equilibrium—very much á la Newton.

Figure 1 shows a precessing toy gyro supported on a wheeled carriage. The carriage is oscillating as the result of the (sinusoidal) component of the centrifugal force acting along its axis of travel, and carries a spirit level, the bubble of which shows a horizontal acceleration in phase with the gyro orientation, produced by the gyro's centrifugal force.

Since the gyro weighed 90 g, the carriage 185 g, and the gimbal ring radius was 4 cm, the carriage displacement amplitude was ±1·3 cm at all precession rates—exactly as predicted by Newton.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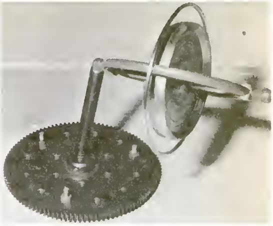
2

Figure 2 shows a somewhat simpler demonstration, in which the support pillar is a flexible coil spring. When loaded with the 90 g weight of the gyro the horizontal stiffness at the top is 22 g wt/cm. With the gyro precessing at 1 rev/sec the spring was deflected 0·7 cm by a horizontal (16 g wt.) centrifugal force a result which most schoolboys—and (I hope) Professor Laithwaite also—could rapidly have predicted using Newton's laws.

A. E. Laws

Perpetual Motion Machines Ltd
53 Beaumont Avenue
St Albans, Herts

Sir,—Robert Walgate's calculations on Professor Laithwaite's gyroscopes make the mind boggle (Monitor, 9 January, p 53). Those who watched the Christmas lectures on BBC2 might well agree that $a=1$m, $r=0{\cdot}2$m, but never that $\omega=10^4$ rad/s! If one further estimates the mass of the gyro, M, to be 10kg, then the moment of inertia will be $Mr^2=0{\cdot}4$ kg.m², and the rotational energy, $1/2 \times I\omega^2=2 \times 10^7$ J. If the electric drill used to spin up the gyro had a mechanical power output of a few hundred watts, then it would have taken the best part of a day to do it! (It would also have had to turn at about 100 000 rpm, and the tangential speed of the flywheel periphery would have been several thousand mph.)

From memory, I would guess that the boy and gyro referred to precessed through one revolution in about three seconds. This makes Ω about 2 rad/s, and from $Mga=Mr^2\omega\Omega$ a corresponding value for ω of about 125 rad/s, which seems much more reasonable. The centrifugal force should be $Ma\Omega^2$, which is 0·4 of the flywheel's weight, and this must surely be readily detectable.

Pending further investigation, I am quite prepared to accept Professor Laithwaite's statement that no centrifugal force of such a magnitude does exist.

R. G. Roscoe

Shrewsbury School
Shrewsbury

Robert Walgate writes :
Mr Roscoe is correct. Unfortunately Professor Laithwaite publishes no figures and my estimate of ω was too high. The boy must have felt a pull outwards of the value Mr Roscoe estimates, though he was well strapped with safety belts to withstand it. In Laithwaite's less spectacular demonstrations with smaller, faster gyros the ratio of centrifugal force to weight $(g/rw^2)(a/r)^3$, is much smaller and the force insignificant.

Intellectual property

Sir,—I am currently engaged in legal research into the ownership of intellectual property (inventions and ideas, confidential materials and techniques, etc.), especially within the sphere of the contract of employment. The intention of this research is to make a review of the current law, to see to what extent it is reflected in current industrial practice, and if necessary to suggest ways in which the law be amended so as to encourage greater inventiveness among employees.

I would be very interested to hear of any personal experiences which have befallen your readers, where ideas or inventions have been awarded, facilitated or encouraged by employers, or where endeavours have gone unrewarded and some degree of exploitation has taken place. All information received will be treated in the strictest confidence.

Jeremy Phillips

University of Kent at Canterbury
Keynes College
The University
Canterbury
Kent CT2 7NP

CLASSIFIED ADVERTISEMENTS

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128 Long Acre, London, WC2E 9QH.
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APPOINTMENTS AND SITUATIONS VACANT

Imperial College of Science and Technology

Lectureship in Mineral Technology

Applications are invited for the post of Lecturer in Mineral Technology in the Department of Mining and Mineral Technology, Imperial College of Science and Technology, (Royal School of Mines).

Applicants should have a good Engineering degree and industrial experience in mineral processing. Teaching experience is desirable but not essential.

The successful candidate will be required to give lectures and organise laboratory work in Mineral Technology at undergraduate and postgraduate levels, especially in the area of Mineral Process Analysis and Design. He will be expected to develop his own interests in one of the main fields of Departmental research activities.

The appointment will date from 1st August, 1975 or as early as possible thereafter.

Initial salary, depending on age, qualifications and experience, will be within the Lecturers scale of £2118 to £4896 plus £399 per annum London Allowance and Threshold payments. FSSU/USS superannuation benefits apply.

Further information and an application form can be obtained from Professor E. Cohen, Department of Mining and Mineral Technology, Royal School of Mines, Imperial College of Science and Technology, London SW7 2BP.

QUALIFIED

GEOPHYSICIST

Required for contracts at home and abroad. Some experience of marine continuous reflection profiling essential.

Please write giving brief details of career to date, age, salary, etc., to **B. E. G. Bizzell, 24 Horsham Avenue, Peacehaven, Sussex.**

German/English Translator

not less than £3000

Schering Chemicals Limited require a technical translator to join the staff of their Medical Department at their Head Office in Burgess Hill, Sussex.

Applicants should have a fair knowledge of medical and scientific technology and, although not essential, an ability to type would be an advantage.

This post offers good career prospects as it involves the establishment of a new service which means that there will be scope for future expansion.

Fringe benefits include a contributory pension scheme with free life cover and subsidised canteen facilities. On joining the Company assistance with removal expenses will also be provided.

The salary is negotiable and will depend on the experience of the successful applicant.

Interested applicants should contact:—
The Personnel Officer
Schering Chemicals Ltd.
Burgess Hill, Sussex
Telephone: Burgess Hill 6011

The Water Research Centre with its two main laboratories, one at Medmenham, Bucks: and the other at Stevenage, Herts; is the national centre for water research in the United Kingdom. With a total staff of 450 it is one of the largest water research organisations in the world. It is financed principally by the Regional Water Authorities as Members and is grant-aided by the Department of the Environment.

WATER RESEARCH CENTRE

Scientist/Engineer

HYDROGEOLOGY

to run a laboratory concerned with the determination of the hydraulic properties of soil and rock. The laboratory will include well simulator models. The experimental programme will be directed primarily towards investigation of the processes that govern the infiltration and movement of water through unsaturated zones of soils and rock.
Candidates should have an honours degree in science or engineering and some industrial or academic experience. Previous laboratory experience would be an advantage but is not essential.

Salary, depending on age and experience, in the grade £1,688-£2,836 and £2,609-£3,573 equivalent to SO, HSO in the Civil Service, but with National Water Council Contributory Pension Scheme. Salary is subject to an additional threshold payment of £243.12 p.a.

Please write or telephone for an application form, quoting Post No. 59.

WATER RESEARCH CENTRE,
MEDMENHAM LABORATORY,
P.O. Box 16, Ferry Lane, Medmenham
Marlow, Bucks SL7 2HD.
Tel: Hambleden, Bucks (049 166) 531

UNIVERSITY OF BRISTOL

Department of Mechanical Engineering

RESEARCH APPOINTMENT

Applications are invited for the post of Research Assistant to join a team working under the direction of Drs. E. G. Ellison and W. J. Plumbridge in the field of fatigue and creep at elevated temperatures. Materials problems encountered in nuclear powered reactors and conventional steam generation plant are being studied and the post relates to the prediction of long-term material response to complex loading.

This work is carried out in collaboration with industry and is funded by the Science Research Council.

Candidates should ideally possess a good first degree in Engineering, Metallurgy or Physics, and either a higher research degree or equivalent industrial research experience. Appointments would be for a period of three years.

Starting salary up to £2412 per annum (depending on age and experience) x £177 to £3285 per annum plus threshold payments of £230 per anuum.

Applications, giving academic qualifications, details of experience, and the names of two referees, should be sent to: Professor C. Andrew, Department of Mechanical Engineering, University of Bristol, Queen's Building, University Walk, Bristol BS8 1TR. Informal enquiries are welcome by telephone: 0272 24161 (extension 143).

THE POLYTECHNIC OF NORTH LONDON
Holloway, London, N7 8DB

Applications are invited from graduates for the post of

LECTURER GRADE II

in the

DEPARTMENT OF FOOD SCIENCES

The lecturer appointed will be required to teach food science and nutrition to students studying for the NCHEE Diploma in Home Economics and the PNL Diplomas in Dietetics, as well as applied science to HND in Institutional Management students. Research and teaching experience in food science/nutrition is required and a higher degree and/or practical laboratory experience in foods or nutrition would be an advantage.

SALARY SCALE: £2700 – £3474 (Under Review) plus £351 London Allowance. In addition, the Threshold Agreement is applicable.

Apply for further particulars and application form to the **Deputy Establishment Officer, The Polytechnic of North London, Holloway Road, London N7 8DB.**

MEDICAL RESEARCH COUNCIL

Laboratory Animals Centre

SENIOR TECHNICAL POST

Applications are invited for post of Senior Technician (Animal) in charge of Isolation Area of the Laboratory Animals Centre, which includes Germ-Free Unit, quarantine room, sheep and goats and experimental animals. This interesting and varied post requires a Fellow of IAT with experience in germ-free technology, a wide knowledge of animal husbandry techniques and the management of staff. Ability to liaise with staff of all levels essential.

Salary range £2520-£3573 plus £126 London Weighting: 4 weeks annual leave plus official holidays: Superannuable post: social club.

Apply to Chief Technician's Office, Medical Research Council, Laboratory Animals Centre, Woodmansterne Road, Carshalton, Surrey, SM5 4EF.

Engineers and Metallurgists

Rank Xerox is a name linked with the future. Currently we are engaged in the development of an advanced range of copier/duplicators and graphic communications equipment – products which are destined to be among the most significant ever produced by the Company. In order to assist with these tasks we are seeking the following personnel:

Senior Mechanical Engineer

To maintain and update test machines, rigs and equipment ensuring minimum downtime. To progress new machines and rigs ensuring spares and supplies are available. Considerable liaison with other departments will be involved.

The applicant will be a mechanical or electromechanical engineer, educated to at least HNC level, with a demonstrated practical learning. He must be self motivated and have design related experience.

Metallurgist

To assist with the development of a range of precision components made by a variety of processes. Experience of modern metal forming processes is essential as well as methods of evaluating surface finish and physical properties. Minimum qualifications HND or BSc Metallurgy with industrial experience.

Packaging Engineer

A Graduate or equivalent in chemistry/general science or material sciences is required to take responsibility for the design of packaging for the xerographic components currently under development for a new range of machines. In addition this compatability of these new components needs to be investigated and a close interaction with development staff will be required. Experience in the packaging industry would be an advantage.

The Company fringe benefits are above average and include 4 weeks' annual holiday, life assurance, contributory pension scheme and generous assistance in relocation expenses where appropriate.

Please write for an application form to **A. Preston, Rank Xerox Limited, Bessemer Road, P.O. Box 17, Welwyn Garden City, Herts.**

RANK XEROX

ENGINEERING GROUP

UNIVERSITY OF CAMBRIDGE
M.R.C. BIOCHEMICAL PARASITOLOGY UNIT

ELECTRON MICROSCOPE ASSISTANT

to operate and routinely maintain a Philips EM 300. Must be skilled in all basic EM procedures including photography and have HNC or equivalent qualification. The holder of the post will be expected to assist staff in research on cell biology of parsitic protozoa and will have opportunities to develop specialised techniques.

Salary £2445–£2985 depending on qualifications and experience.

Applications including curriculum vitae and names of two referees to **The Director, Molteno Institute, Downing Street, Cambridge, CB2 3EE.**

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL

Post doctoral biochemist required as a Research Assistant, to work on biochemical abnormalities in cultured cells. Appointment initially for one year, renewable for a further two years. Salary £2118 to £2412 on the University of London Non-clinical Lecturers plus London Allowance and Threshold Allowance. FSSU superannuation. Further details and application forms from Dr. D. Brenton, Department of Human Metabolism, University College Hospital Medical School University Street, London WC1E 6JJ.

Assistant Information Officer

Roche Products Limited, the UK subsidiary of the Swiss pharmaceutical company, F Hoffmann-La Roche AG, is a major pharmaceutical company and operates extensive research activities at its facilities in Welwyn Garden City. Hertfordshire.

Research at Welwyn is undertaken by a number of multidisciplinary project teams. The provision of an effective scientific information service is vital to the efficient functioning of these teams, and we are seeking an Assistant Information Officer to take part in this work. Both manual and computer-based information retrieval systems are in use, and an on-line computer-based system is to be installed in the near future. The person appointed will be expected to play an immediate part in the maintenance of existing systems and the answering of enquiries, and will eventually assist in the design and development of new systems.

The successful candidate is likely to be a graduate in chemistry, biochemistry or some other biological science, preferably with experience in information work in a biomedical environment. A good reading knowledge of German and French is essential, as is an ability to communicate both verbally and in writing with scientific staff at all levels.

The Company offers above average Conditions of Service and accommodation in a recently constructed facility. If you would like to apply for the post please write quoting reference R90 to the Welwyn Personnel Manager.

ROCHE

Roche Products Limited
Welwyn Garden City, Hertfordshire AL7 3AY

SCIENTISTS

Radiological Protection Services

The National Radiological Protection Board's Services Department provides advisory and practical services associated with the use of ionising radiation, including radiological protection in industry, hospitals, schools and research establishments.

Vacancies exist in Services Centres at Harwell and Leeds. Candidates with experience directly relevant to some aspects of radiological protection will be preferred. However, applications from inexperienced candidates with a degree, Higher National Diploma, or Higher National Certificate in a relevant subject will also be considered.

The grades and salary scales appropriate to these appointments are:-

Scientific Officer	£1705 — £2865
Higher Scientific Officer	£2635 — £3610

For further information and an application form ring or write to:-
The Personnel Officer, (Ref: A69),
National Radiological Protection Board,
Harwell, Didcot, Oxfordshire.
Tel: Rowstock 600 (STD 023-583) Ext. 216.

Closing date for applications 28th February.

National Radiological
Protection Board

THE OPEN UNIVERSITY

COURSE ASSISTANT IN BIOLOGY

Applications are invited for a post of Course Assistant in Biology, tenable from the 1st March 1975, or as soon as possible thereafter. The person appointed will be responsible for a wide range of academic and administrative services to Course Teams producing multi-media courses in Biology. He/she will have particular responsibility for the experimental aspects of Biology courses and will be closely involved in the organisation of Day Schools and with the preparation of the experimental work undertaken by students at their annual residential Summer School.

Applicants should have a degree in biological science, prefersbly with a special interest in physiology and biochemistry.

The appointment will be for three years initially. Commencing salary within scale: £1638–£2757 per annum.

Further particulars are obtainable from the Personnel Manager (CB1), The Open University, P.O. Box 75, Walton Hall, Milton Keynes, MK7 6AL. (Tel: Milton Keynes 74066, extension 3068.)

Closing date: Friday, 21st February, 1975

INNER LONDON EDUCATION AUTHORITY

London College of Furniture,
41-71 Commercial Road,
London E1 1LA

Applications are invited for the post of

LECTURER II

in Applied Science and Engineering.

The person appointed would have responsibility for studies concerned with structures.

The science section serves the college in many areas including material and environmental sciences, acoustics, electronics and engineering closely related to the courses of study in Timber and Furniture, Furnishing and Interior Design, Musical Instrument Technology.

SALARY—in accordance with the Burnham (FE) Report (under review). Lecturer Grade II—£2700-£3474 (plus London Allowance—£351 and threshold payments).

Further details and application form (returnable within 14 days) obtainable from the Senior Administrative Officer at the College.

MEDICAL RESEARCH COUNCIL

SCIENTISTS

The Medical Research Council's Cyclotron Unit has vacancies for two scientists in the Radiobiology Section. The research is mainly concerned with the response of cells and tissues to ionizing radiation, and is closely linked with the treatment of cancer using fast neutrons.

Applications are invited from suitably qualified candidates:

(i) to investigate the response of the nervous system.

(ii) to investigate the response of cells in *vitro* to charged particles from the MRC's cyclotron.

Candidates must have a PhD or equivalent medical or veterinary qualifications.

Applications should be made in writing, giving full personal particulars, to the Director, Medical Research Council, Cyclotron Unit, Hammersmith Hospital, DuCane Road, London W12 0HS.

Microbiological Research Establishment

Two vacancies exist in the experimental plant concerned with research projects involving the study of a wide range of micro organisms:—

MICROBIOLOGIST

. . . to take charge of the Microbiological Control Laboratory. The work involves production of seed cultures for use in main plant and microbiological analysis of samples from plant cultures (Ref: SA/7/FQ).

ANALYTICAL BIOCHEMIST

. . . to take charge of the Analytical Laboratory. Duties include analysis of culture and extraction samples with most emphasis on enzyme assays (Ref: SA/8/FQ).

Qualifications: Candidates (aged under 30) must have a degree, HNC or equivalent in an appropriate scientific subject.

Appointment will be as Higher Scientific Officer (around £2700 to £3600) or Scientific Officer (over £1800 to £2900) according to age and experience.

Application forms (for return by 28 February 1975) from Deputy Director, Microbiological Research Establishment, Porton Down, Salisbury, Wilts. Please quote appropriate reference.

Science group
CIVIL SERVICE

Procurement Executive, Ministry of Defence

New opportunities in Pharmaceutical research and development

New pharmaceutical and veterinary formulation laboratories are due for completion during 1975 in our Research Institute at Dagenham, and we are planning a substantial expansion in facilities during 1975-1976.

We are seeking pharmacists, or chemists with relevant experience, to fill a number of new posts.

The work involves formulation of new research compounds, preparation of quantities for pharmacological and toxicological tests, and later for pharmacokinetic studies and clinical trials, as well as development of laboratory scale processes.

The new facilities provide for formulative and preparative work on all the usual dosage forms and consequently work is varied and affords the opportunity to broaden experience or to gain expertise in special fields. Liaison with other research scientists in our multi-disciplinary research teams is an integral part of the work; publications and attendance at scientific meetings are encouraged.

Duties include supervision of technicians and pre-registration students and preparation of technical reports.

Applicants should have an appropriate pharmaceutical or chemical qualification. For the more senior posts, post-graduate and/or industrial experience is required.

Benefits of employment include flexible working hours, subsidised canteen, contributory pension fund and free life assurance. Assistance with relocation will be considered.

Please write, giving details of qualifications and experience to the Personnel Manager, May & Baker Ltd., Dagenham, Essex RM10 7XS, quoting reference number 18/NS/1, or telephone Elizabeth Jones on 01-592-3060 extension 506 for further information.

M&B May&Baker

ASSISTANT INFORMATION OFFICER

£2511 - £2718 plus Threshold payments

The Severn Trent Water Authority covers an area of 8,500 square miles and serves a population of 8½ millions.

An Assistant Information Officer is required to provide an enquiry service and to assist in the establishment of selective discrimination of information (S.D.I.) service to both Headquarters and Divisional Staff. The person appointed will report to the Information Officer, who has overall responsibility for library and information services. The work will involve participation in a computerised indexing and retrieval system under development by a group of Water Authorities.

The successful candidate will have a qualification in information science or experience in a special library. A relevant technical background would be an added advantage.

Application forms and further information are obtainable from
Regional Personnel Manager,
Abelson House 2297 Coventry Road,
Sheldon, Birmingham 26.
Closing date 24th Feb.

SEVERN TRENT WATER

ROYAL MILITARY COLLEGE
OF SCIENCE, Shrivenham

Research Scientist

(Signal Processing)

. . . to join a team researching problems of acoustic-signal processing as applied to vehicle recognition systems. Excellent research facilities are available and the publication of results is encouraged. The opportunity exists to work for a higher degree.

Candidates must have a 1st or 2nd class honours degree in Electrical Engineering or Physics (with Electronics), with at least 2 years' postgraduate R & D experience. Experience in modern electronic signal processing and computer data processing and interest in field trial work would be an advantage.

Appointment, initially for two years as Higher Research Scientist (£2690 to £3600) or Senior Research Scientist (£3386 to £4660) depending on experience. Accommodation for single staff available, possibility of housing for married candidate.

Application forms (to be returned by 28 February 1975), from Civilian Admin. Office, Royal Military College of Science, Shrivenham, Swindon, Wilts. Telephone 0793 782551. Ext. 421. Further details of post from Professor P. C. J. Hill. Ext. 290. Please quote ref: SC/12EP.

A Higher Scientific Officer

is required by the

Central Unit On Environmental Pollution, London

to assist with new and ongoing appraisal studies of specific pollutants in air, water and on land; to help in assessing scientific developments in the relevant areas and to maintain up to date information on certain selected pollutants; to assist in providing scientific advice on a day-to-day basis to other Government Departments and to the general public; to help service a number of science oriented committees.

Appointment as Higher Scientific Officer will be for 3 years initially with a possibility of an extension for a further 2 years. Starting salary ranges from £2871 to £3781 plus £229 p.a. threshold payments. Applicants must have a Degree or HNC in a physical science and experience relating to pollution.

Please write for an application form quoting (PMT2/ESA 15/157/05) to the Department of the Environment, Room 446, Lambeth Bridge House, Albert Embankment, London S.E.1 (or telephone 01-211 3325 or 7158). Closing date for application forms February 27th, 1975.

Department of the Environment

LONDON BOROUGH OF BARNET

EDUCATION DEPARTMENT

PART-TIME LABORATORY ASSISTANT

required at Bishop Douglass School, Hamilton Road, Finchley, N.2. to work 25 hours weekly, 40 weeks per annum. Duties include assisting with assembly, care and maintenance of apparatus, preparation of equipment and use of chemicals, etc. Salary within range £967–£1007 per annum including London Weighting, age 21 years and over (pro rata to full-time rate); plus 'threshold' allowance, approximately £96 per annum. Additional payment for recognised qualifications.

Application form from Director of Educational Services, Town Hall, Friern Barnet, N11 3DL (Ref: ADM/S/516a).

R. H. WILLIAMS
Chief Executive and Town Clerk

ORGANIC CHEMIST

An opportunity has arisen in our Organic Chemistry Department for a young graduate to work on the synthesis of organic intermediates on both bench and production scales.

The post would particularly suit a person with an Honours Degree in chemistry and with some experience in synthetic organic chemistry.

Salary negotiable.
In the first instance write giving career details to:

Dr J. Jappy
Projects Manager
Fulmer Research Institute
Stoke Poges
Slough SL2 4QD

GRADUATE FOR NUTRITION/TOXICOLOGY RESEARCH & HEAD OF ANIMAL UNIT

The Lord Rank Research Centre in High Wycombe provides research and development facilities for the whole of the Ranks Hovis McDougall Group of Companies, whose activities cover agricultural, milling, baking and convenience food products.

A vacancy has arisen in the Department of Animal Nutrition and Toxicology for a graduate to join a team of scientists working on a variety of long and short-term projects concerned with the nutritional and safety evaluation of food and feedingstuffs. This includes a large programme evaluating novel protein as a potential food component. This position also includes the opportunity to be responsible for overall management of the department's Animal Unit. The successful applicant will be a graduate in a relevant biological science and will probably have three to four years experience in either toxicology or nutrition work associated with an animal unit using typical laboratory animals. Previous experience of running such a unit is not an essential requirement of this position.

The salary offered will be up to £3000 p.a. dependent upon age and experience and other terms and conditions of employment are excellent.

Apply quoting reference N2, to:

The Personnel Officer
The Lord Rank Research Centre
Lincoln Road, High Wycombe
Buckinghamshire HPIZ 3QR

RANKS HOVIS McDOUGALL LIMITED

UNIVERSITY OF YORK

Department of Chemistry

RESEARCH TECHNICIAN (GRADE 3)

Applications are invited for a post in the Research Laboratories. The work involved includes assistance with the research of a member of staff on studies on the oxidation of organic compounds (of biological interest) and, secondly, assistance in the operation of either the mass spectrometer or nmr services. Experience in either technique is important.

The minimum qualifications required are C & G 735 (Adv) certificate or ONC/HNC in Chemistry.

Salary will be paid on Grade 3 of the University Technicians' scales (£2013-£2343), with entry at a point appropriate to qualifications and experience.

Further details and application forms may be obtained from the Laboratory Superintendent, Department of Chemistry, University of York, Hestington, York YO1 5DD. Closing date for completed application forms: Friday 21 February, 1975.

BEDFORDSHIRE EDUCATION SERVICE

Pilgrim School, Bedford

QUALIFIED LABORATORY TECHNICIAN

(man or woman) required as soon as possible. Salary £1410 if aged 21 or over rising to a maximum of £1866 per annum.

Further particulars and application forms may be obtained from the Headmaster, Pilgrim School, Brickhill Drive, Bedford MK41 7PZ. Telephone 50612.

REACTOR PHYSICS ASSISTANT required at

BRADWELL POWER STATION

The successful candidate will assist in the day to day optimisation of the reactors, in the long term planning of refuelling programmes, and in analytical studies of reactor behaviour.

Applicants should have a degree in Physics, Mathematics, or Engineering, or equivalent qualifications.

Experience of reactor design, commissioning, or operation, could be an advantage.

Salary within a scale rising to

£4754 p.a. (NJB Agreement)

Applications quoting Vacancy No. 71/75 giving full details should be forwarded to the Station Superintendent, Bradwell Power Station, Bradwell-on-Sea, Southminster, Essex to arrive by 14th February 1975.

Findyourplace in British Gas

TECHNICAL OFFICER

London up to £3744

A Technical Officer is required by the Operations Division at London Research Station to undertake laboratory and field work related to exploration activities, underground storage in geological formations, and factors affecting natural gas quality. Field work involves visits to wells on and off-shore, and to shore terminals. Candidates should have HNC Chemistry, together with a current driving licence; an interest in on-line process instrumentation would be an advantage. Starting salary will be according to age and experience on a scale rising to £3309 or exceptionally £3744 including Threshold payment. For further details and an application form, contact the Research Secretary, British Gas, London Research Station, Michael Road, Fulham, London SW6 2AD, quoting reference (NS) 4000/14/ES.

BRITISH GAS

Optical Communications

British Insulated Callender's Cables Limited has a vacancy in a group concerned with fibre-optic communication techniques.

The successful candidate will join a team endeavouring to convert laboratory demonstration into practical communications systems. The work involves the development of cables using high grade optical fibres and includes the measurement of attenuation and bandwidth, design of joints and performance evaluation on finished cables. Some topics are studied in collaboration with other laboratories, especially where systems development is involved.

A degree in physics, electrical engineering or glass technology would be a suitable qualification and relevant background experience an added advantage.

The laboratories are modern, well-equipped and conveniently situated to the Central Line. There are adequate off-street parking facilities.

Applications to:—

Administration Manager,
British Insulated Callender's
Cables Limited,
Central Research and
Engineering Division,
38 Wood Lane,
London, W12 7DX.

BICC

Department of the Environment
Building Research Station,
Garston

SOCIAL/PHYSICAL SCIENTISTS

Applied research in urban and regional planning

Join multi-disciplinary teams carrying out research projects to assist development of future Government policies in planning field. Current studies relate to environmental evaluation, development control, housing market, employment and assessment of shopping developments.

Candidates (normally aged under 32) must have a degree or equivalent in an appropriate scientific or social science subject.

Appointment as Senior Scientific Officer (£3350 to over £4650), Higher Scientific Officer (over £2650 to £3600) or Scientific Officer (over £1800 to £2900) according to age, qualifications and experience.

For further details and an application form (to be returned by 20 February 1975) write to Mr A. G. Moore, Building Research Station, Garston, Watford, Herts WD2 7JR, quoting ref: SA/78/HA.

CENTRAL ELECTRICITY GENERATING BOARD

SCIENTIFIC SERVICES RATCLIFFE ON SOAR, NOTTINGHAM

RESEARCH OFFICER

AIR POLLUTION OFFICER

VACANCY NO.(NS)47/75MR.

The successful applicant will be a chemist or physicist and will join a group in the Applied Physics Section engaged in both long term research and short term service work into the effects of gaseous and particulate emissions, from power stations, on the environment. Currently a major investigation is being conducted into the long range drift of sulphur dioxide. This involves large scale field experiments as well as mathematical modelling of the dispersal process. The person appointed will be expected to contribute to both aspects of this work.

Applicants should have a good honours degree and research experience in one or more of the following fields: meteorology, aerodynamics, chemical kinetics or atmospheric diffusion.

A current driving licence is essential.

STRESS ANALYST

VACANCY NO.(NS)48/75MR.

Applications are invited for a Research Officer to join the Mechanical Sciences Section of the Engineering Sciences Branch. Candidates should have a good honours degree in applied physics, mathematics, theoretical mechanics or mechanical or structural engineering. They will join a small team working closely with materials technologists and other experts in the areas of finite element stress analysis, fracture mechanics, structural engineering and strain data evaluation. Experience in one of the above fields, preferably stress analysis, is essential, as is a current driving licence.

The above appointments will be within NJB conditions and the salaries for the posts will be within Bands 2, 3 or 4, depending on age and experience. The current salaries for these Bands are:

Band 2: £3925—£4875/£5325 + £100 p.a. + £229.35 Threshold Payment.
Band 3: £3300—£4425 + £100 p.a. + £229.35 Threshold Payment.
Band 4: £1975—£3700 + £100 p.a. + £229.35 Threshold Payment.

Applications should be in writing, quoting the appropriate vacancy number and giving details of age and experience to the Personnel Manager, CEGB Midlands Region, Haslucks Green Road, Shirley, Solihull, West Midlands, B90 4PD by 18th February 1975.

Midlands Region

CHELSEA COLLEGE
University of London
TECHNICIAN GRADE 3

with Physical/Chemical or Biological/Physical experience is required to work in a membrane group. The appointment is for one year initially, with the possibility of extension. Salary in the range £2013 to £2343, plus £410 London Allowance. Application forms obtainable from the Superintendent of Laboratories, Department of Chemistry, Chelsea College, Manresa Road, London SW3 6LX.

REQUIRED SEPTEMBER

someone to teach general science to public school common entrance and scholarship standard. St. Christopher's School, 33 New Church Road, Hove, East Sussex BN3 4AD. Tel No: Brighton (0273) 735404.

HERIOT-WATT UNIVERSITY, EDINBURGH
Department of Physics

2 SRC POST-DOCTORAL RESEARCH ASSOCIATES

The Tunable Infrared Laser Group has a rapidly expanding programme of ultra-high resolution spectroscopy, mainly of molecules, using the Spin-Flip Raman Laser. Technically competent scientists are required to develop the frequency stability, power and wavelength range of both pulsed and c.w. Spin-Flip Raman laser systems with a view to fully utilising the vast increase in spectral brightness now available for new science. The position offers considerable scope for personal initiative. Candidates with experience in such fields as spectroscopy, laser physics, solid state device physics, semiconductor materials growth and electronics will be considered seriously. Salary will be in accordance with qualifications and experience, with posts renewable for up to 5 years. Application forms and further details may be obtained from **Professor S. D. Smith, the Physics Department, Heriot-Watt University, Edinburgh (031-449-5111).**

BEDFORDSHIRE EDUCATION SERVICE
Southern Area
QUEENSBURY UPPER SCHOOL
Langdale Road,
Dunstable LU6 3BU
Headmistress:
Miss C. M. Scott BA
Number on Roll 1268

Required as soon as possible Master or Mistress to teach
SCIENCE
preferably
PHYSICS
to at least 'O' level, with possibility of 'A' level work for a suitable candidate. Integrated Science is taught to the School's first year entry (3rd year) and the successful candidate will be expected to take part in this teaching. Scale 2 for suitable applicant—temporary or part-time considered.

In September 1972 two grammar schools received the first 13+ non-selective entry and combined in their existing building on one site to form a mixed comprehensive school.

Assistance may be given with mortgage facilities and 50% of approved removal expenses if required.

Applications by letter direct to the Headmistress as soon as possible.

ROYAL POSTGRADUATE MEDICAL SCHOOL
University of London
GRADUATE CHEMIST or BIOCHEMIST

required to join multidisciplinary group studying the effects of diabetes on the retina. The appointee will be responsible for biochemical studies of the retina, including uptake and utilization of glucose and the effects of diabetes on these processes.

Salary on scale £2268-£2781 per annum + threshold payment according to age and experience. Ref No 20/295.

TECHNICIAN/JUNIOR TECHNICIAN

required to take part in research programme on prostaglandins in human disease. Experience in chromatography techniques an advantage. Minimum qualifications 4 GCE "O" level passes in English, Maths and 2 Science subjects.

Salary on scale £1077-£1848 or £1995-£2494 per annum + threshold payment, according to age and qualifications. Ref No 20/469.

Applications to the Personnel Officer, RPMS (tel 743 2030 Ext 93). Hammersmith Hospital, DuCane Road, London W12 0HS, quoting the appropriate ref no.

UNIVERSITY OF WALES WELSH NATIONAL SCHOOL OF MEDICINE
Heath Park, Cardiff

Applications are invited for the post of a
UNIVERSITY GRADE 5 TECHNICIAN
who will work for an MRC-supported group in Whitchurch Hospital, Velindre Road, Cardiff.

The group does research into the biochemical bases of mental illness and mode of action of psychotropic drugs.

Salary will be in the range of £2439 to £2895 according to age, experience and qualifications and the initial contract will be for a period of 3 years. The starting date is 1 June, 1975.

Further particulars may be obtained from the Registrar, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN.

HEAD TECHNICIAN

(£3624 - £4227)

Division of Hormones and Blood Products

The National Institute for Biological Standards and Control is concerned with the preparation, characterisation and issue of international and national standard reference materials for a number of important therapeutic, prophylactic and diagnostic biological substances which are widely used in medical treatment.

An opportunity arises for a man or a woman with the right background to become Head Technician of the DIVISION OF HORMONES & BLOOD PRODUCTS in this new and expanding Institute.

The successful applicant will in addition to divisional administrative duties be required to carry out a defined aspect of laboratory work under the direction of a member of the scientific staff. The post offers scope to the right candidate to participate in the future development of the Institute which, in approximately five years time will move to new purpose-built premises just north of London.

Salary on Chief Technician (NHS) scale plus London Weighting (under review) and Threshold Payments.

Apply, quoting reference No. 0045, for application form and job specification to R. S. Dunn, Personnel Officer, National Institute for Biological Standards and Control, Holly Hill, Hampstead, London NW3 6RB. Telephone: 01 435 2232, Ext. 16.

NIBSC

National Institute for Biological Standards and Control

THAMES WATER AUTHORITY

SOUTHERN DIVISION

Assistant Chemist/ Works Manager

(Water Supply)

Salary range £2613—£3063

plus threshold payment and appropriate car allowance

At the Divisions Shalford Water Treatment Plant. Duties include chemical and bacteriological examination of water samples from sources, reservoirs etc. and management of the Shalford Works.

Generous assistance may be given towards house and purchase and out of pocket removal expenses.

Application giving personal details, qualifications and experience with the names of two referees to:—

The Divisional Manager, Thames Water Authority,
Southern Division, Filmer Grove, Nightingale Road,
Godalming, Surrey, GU7 3AD.

Applications to be received by 14th February 1975.

TECHNICAL MANAGER

A vacancy caused by the internal promotion of the present Technical Director to another post within the group exists within Cementation Chemicals, a subsidiary company of the Trafalgar House Group.

The Company's activities include the manufacture and supply of chemicals to the construction and drilling industries, as well as providing specialist contracting services.

The applicant will be required to co-ordinate and lead the Company's technical resources. He will probably be in his thirties, a trained Chemist or Materials Scientist. Management experience in industry is essential and ideally he will have knowledge of construction products and processes.

The appointment is based at the Company's Mitcham Head Office but travel will be involved. The appointee will report direct to the Managing Director.

A good salary is offered plus company car and usual fringe benefits.

Please write to:
G. Collett Esq., Divisional Personnel Manager,
Cementation Chemicals Limited,
Mitcham House 11, 681 Mitcham Road,
Croydon CR9 3AP.

Cementation

Editorial Appointment

The Council, which is the main government agency for the promotion of medical research, has a vacancy at its headquarters office in London for a man or woman with scientific qualifications and/or experience in editing and drafting scientific publications to be responsible for the editing of Council's official publications, including its Annual Report and scientific handbooks.

Salary will be in the range of £3363 - £3995 per annum, depending on qualifications and experience, plus £229 per annum threshold payment. Annual leave 22 days; superannuation provision. Appointment will be subject to a probationary period of one year.

Please write or telephone Miss M. Gale, Medical Research Council, 20 Park Crescent, London WIN 4AL (01 636 5422, Ext. 35) quoting Ref. E2/615 for an application form, which should be returned by February 14th, 1975.

MRC

Medical Research Council

Chemical Analysts

based initially at Cockfosters, moving to Gravesend, Kent in approx. 2 years

Up to £3805 p.a.

Vacancies exist in the Chemical Analytical Laboratory of the Scientific Services Department which examines a wide range of materials associated with the generation and transmission of electricity. This work which includes the analysis of metals waters and oil using instrumental and wet techniques calls for general experience in practical chemistry.

Candidates should possess relevant qualifications preferably to HNC standard or equivalent but consideration will be given to those below this level for whom day release for further study may be permitted.

Salary within a scale rising to £3805 p.a. (NJB Agreement).

Applications giving age, qualifications and details of experience quoting Vacancy No. 1033/75/NS should be sent to the Personnel Officer (Recruitment), Bankside House, Sumner Street, London SE1 to arrive by 14th February 1975.

Add power to your career

Central Electricity Generating Board

south east

SCIENTIST

The Applied Physics Department of the Ontario Research Foundation has an opening for a graduate with a materials science, physics or metallurgical background, with some experience in industrial or government laboratories, to join a small group specializing in electron optical contract services. Applicants with experience in electron probe micro-analysis, transmission or scanning electron microscopy will be given preference. The ability to supervise staff and to prepare short scientific reports is essential. The successful applicant will be expected to initiate and supervise short term investigations and to participate in longer term applied research studies. A versatile outlook, and the ability to communicate effectively with clients, both orally and in writing, are essential qualities for this position.

Reply in writing to:

Personnel Manager
Ontario Research Foundation
Sheridan Park, Mississauga
Ontario, L5K IB3, Canada

RESEARCH TECHNICIAN

£1945 – £2332, Ewell

For the Biological Sciences Department at Ewell County Technical College. The study is concerned with nitrogen fixation in the rhizosphere and could lead to a PhD.

Applicants should have a basic knowledge of microbiology. A genuine interest in biological methods in agriculture an advantage.

Salary includes Surrey Allowance (£180) and Threshold payment (£229·68). Commencing point according to age, qualifications and experience. Benefits include excellent staff restaurant and car park. 36 hour, 5 day week with 15 days holiday.

Application form from Chief Administrative Officer (please quote ref: CAO/TBS/03) Ewell County Technical College, Reigate Road, Ewell, Epsom, Surrey. Tel: 01-394 1731 (or 24 hour answering service).

SURREY
COUNTY COUNCIL

Scottish Society for Research in Plant Breeding

SCIENTIFIC or HIGHER SCIENTIFIC OFFICER

There is a vacancy for a Plant Breeder in the Forage Department of the Scottish Plant Breeding Station. The officer will work with barley and will be responsible for part of the breeding programme with research in related topics. Qualifications: First or Second Class Honours Degree in a Biological subject or equivalent qualifications. At least two years post graduate research experience are required for appointment as a Higher Scientific Officer. Salary, depending on qualifications and experience—Scientific Officer Scale, £1592–£2675. Higher Scientific Officer Scale, £2461–£3371. Both plus threshold payments currently at a rate of £229 per annum. The post is superannuable.

Application Forms from **The Secretary, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian. EH25 9RF**, to be returned not later than 22nd February, 1975.

Applicants from the Agricultural Research Service should submit their applications through their present director, if they wish to be considered for the award of "public interest" transfer terms.

Scientific Staff Consultants

Offer a free job finding service to all grades of **Technicians** and **Scientists** in **Hospitals, Research, and Industry.**

Phone Miss Eames or Miss Maranelli on 01-831 6471
50, Lincoln's inn Fields, London, W.C.2. (By appointment ONLY)

ELECTRONICS TECHNICIAN

required in Department of Geophysics, University of Reading, for meteorological instrumentation. Opportunity to contribute to design. Salary in scale £2247-£2628 p.a. (Grade 4). Apply with details of qualifications and experience and names of two referees, quoting Ref. TS.8A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

SHERBORNE SCHOOL FOR GIRLS

Dorset will have a vacancy in the Science Department in September 1975 for a graduate prepared to teach Chemistry at any level in the School. Ability to teach some Physics an advantage. Non-resident post. Apply to the Headmistress.

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ST. GEORGE'S HOSPITAL MEDICAL SCHOOL

in association with

Chelsea College and the Royal Dental Hospital of London School of Dental Surgery

(University of London)

Invites applications for the following posts—

SENIOR LECTURER in PHARMACOLOGY

under Professor Rang

SENIOR LECTURER in STRUCTURAL BIOLOGY

under Professor Dilly

SENIOR LECTURER/ LECTURER in BIOCHEMISTRY

under Professor Pasternak

For further particulars write to the Establishments Officer, St. George's Hospital Medical School, Blackshaw Road, Tooting, London SW17 0QT, specifying the post in which interested or telephone 01-672 4286. Closing date for applications 28 February, 1975.

LABORATORY SUPERVISOR

(Male or Female)

We have a vacancy for a laboratory supervisor to be responsible for the day to day running of a routine testing laboratory. The work will include the progressing of samples and distribution of results and will involve a close association with quality control and sales departments.

Minimum qualifications will be 'A' levels or ONC, but previous laboratory experience is more important, and a practical knowledge of GLC or Auto-analysers would be an advantage.

The basic holiday entitlement is four weeks p.a. and an attractive salary will be offered.

Apply, with brief details of experience to:—

Cigarette Components Ltd
30/31, Abbey Estate
Mount Pleasant
Alperton, Wembley
Middlesex

Mr R. L. Bryant

MICROBIOLOGIST

required for interesting and varied work with a long-established firm of analytical chemists specialising in the analysis of feeding-stuffs and related products.

Applications are invited from candidates with recognised qualifications in microbiology (e.g. BSc, LIBiol), and preferably also with an interest in chemical analysis. Experience in the microbiological assays of amino-acids and vitamins in foods or feedstuffs is desirable.

Starting salary will depend on experience and qualifications.

The laboratories are ideally situated on the coast at the South end of the Lake District.

Applications, with details of qualifications and experience, in writing to: Chief Chemist, Aynsome Laboratories Ltd., Grange-over-Sands, Cumbria.

Postdoctoral Biochemist

We have a vacancy in our Biochemistry Department for a biochemist to participate in research on the biochemistry of micro-organisms, directed at the discovery and development of new chemotherapeutic agents. Applications are invited from candidates with a good honours degree in biochemistry and several years postgraduate work which will preferably have resulted in the award of a higher degree in a relevant field of research.

Our research is organised on an interdisciplinary basis and this vacancy provides an excellent opportunity to join an enthusiastic group of scientists working in new well equipped laboratories on a variety of problems in the field of chemotherapy. The biochemistry department contributes to the work of a number of project groups active in various areas of medicinal research. Its activities include drug metabolism, enzyme and lipid biochemistry, and biochemical pharmacology so that the successful candidate will be carrying out research in an environment in which a wide range of biochemical interests are being pursued.

We can offer excellent working conditions and conditions of service which include a contributory pension scheme, BUPA Membership and a Christmas Award. In appropriate cases generous assistance with relocation expenses would be available.

If you are interested in this post please write for further details and Company information quoting reference RB3 to the Welwyn Personnel Manager

ROCHE

Roche Products Limited
Welwyn Garden City, Hertfordshire AL7 3AY

Assistant Information Officer

An Assistant Information Officer is required for our Agrochemical Development Department which is based at the M & B Research Station at Ongar, Essex.

Principle duties will be to assist the Head of Information Unit to collect and disseminate project information efficiently between the Research Station and the Company's Branches and Agents throughout the world.

Applicants aged between 24 and 28, should have a degree (preferably with a science as a main subject), a working knowledge of French, German or Spanish and an ability to summarise technical data in clear English.

Salary is competitive and regularly reviewed. We can also offer four weeks' holiday after one year, a pension scheme with free life assurance and a flexible working hours system.

Assistance with removal expenses will be considered.

Please write giving details of qualifications and experience to the Personnel Manager, May & Baker Ltd., Dagenham, Essex RM10 7XS (quoting reference number 13/NS/1), or telephone Elizabeth Jones on 01-592-3060, ext. 506 for further information.

M&B May&Baker

NORTH EAST LONDON POLYTECHNIC

Senior Technician in ZOOLOGY

Applications are invited for the above post based at our West Ham Precinct, Romford Road, London E15.

The successful applicant will be responsible for the overall supervision and co-ordination of the technical staff and services in the Zoology section of the department. Candidates should have appropriate Zoological qualifications and experience of degree level techniques.

Salary on a scale ranging from £2448 to £2799 p.a. plus the current Threshold Payment of £229·68 p.a. A Qualification Allowance of up to £72 p.a. may also be payable. For further details and application forms please contact The Staffing Office, Ref: S/BJ.165, North East London Polytechnic Romford Road, London E154LZ. Tel: 01-555 0811 Ext 31 or 33.

Closing date: 21 February, 1975.

THE ROYAL MARSDEN HOSPITAL

Technician required immediately to work in the Department of Cytogenetics and Immunology at the Royal Marsden Hospital, Fulham Rd, London SW3. The work involves chromosome studies in malignant disease with particular reference to leukaemia. Previous experience in cytogenetics or haematology desirable but recent graduate in appropriate subjects would be considered. Salary depending on age, qualifications and experience on scale £1304-£2092 or £2215-£3190. Applications to the Administrator.

C.E.G.B. NORTH WESTERN REGION

OPPORTUNITIES IN NUCLEAR POWER at

TRAWSFYNYDD POWER STATION

There is a vacancy for a PHYSICIST, wishing to develop a career in nuclear power generation, at Trawsfynydd Power Station, which is situated in an attractive area of the Snowdonia National Park.

The successful applicant will work on physical aspects of reactor operation, short and long term, and on optimisation of all station conventional plant. Candidates should have a good honours degree in physics or mathematics preferably supported by some experience.

Salary will be within the range £2450–£3800 per annum plus threshold supplement (£229·35 per annum).

Some assistance with housing is available, if required.

Applications in writing giving details of age, experience, qualifications, etc. to the Personnel Manager, Central Electricity Generating Board, 825 Wilmslow Road, East Didsbury, Manchester M20 8RU to arrive no later than 18 February 1975. Please quote vacancy number 753/NS.

Council for Scientific and Industrial Research South Africa

NATIONAL BUILDING RESEARCH INSTITUTE, PRETORIA.

ACOUSTICS RESEARCH

This Institute has a vacancy in the Environmental Engineering Division for a person with a thorough graduate or post-graduate training in acoustics.

The successful applicant will be required to do research into various aspects of architectural acoustics (including work on models) and noise, and to help with the establishment of acoustic performance standards for dwellings. A moderate amount of consulting work is also involved.

Excellent laboratory and computer facilities available.

SALARY: Between R4 560 and R12 600 (£1 = R1·63 approx.) per annum.

Up to 39 days leave per annum; laboratories and offices close between Christmas and New Year; generous sick leave privileges; five-day week; pension, group insurance and medical aid schemes; holiday bonus; subsidy on repayments on housing loans, financial assistance for further study.

Further details and an application form may be obtained from: The Office of the Scientific Counsellor, Chichester House, 278 High Holborn, London, WC1V 7HE. Telephone: 01-242 9641.

NORTH EAST LONDON POLYTECHNIC

Physiology

AN EXPERIENCED TECHNICIAN

is required to join a team responsible for servicing undergraduate and post graduate studies in the life sciences. The post is based in the Department of Biological Science at our West Ham Precinct, Romford Road, E15 which has a wide range of Botany, Zoology, and Physiology laboratories as well as extensive research and specialist facilities. The post is at Senior Technician level and candidates should have appropriate qualifications and/or experience in the field of physiology.

Salary on a Scale ranging from £2127 to £2448 p.a. plus the current Threshold Payment of £229·68 p.a. A Qualification Allowance of up to £72 p.a. may also be payable.

For further details and an application form please contact our Staffing Office, Ref: S/BJ.164, Romford Road, E15 4LZ. Telephone: 01-555 0811 Ext 31.

Closing date: 21 February, 1975.

BUREAUTECH (SCIENTIFIC STAFF AGENCY)

Top jobs for ONC/HNC/HND/AIMLT/B.Sc. (Chem; Phys; Biol; Med. Lab. subjects)

We find you the job free of charge
Tel: 01-959-3517.

EAST SUSSEX EDUCATION COMMITTEE
BRIGHTON TECHNICAL COLLEGE
APPLIED SCIENCE DEPARTMENT

Required as soon as possible

Laboratory Technician in Microbiology

to undertake supervisory and practical duties in Biology and Microbiology Laboratories.

Salary: Within the scale T1 £888–£1866 p.a. + £229·68 Threshold according to age, qualifications and experience.

Qualifications: HNC/HND in Applied Biology with Microbiology as a special subject (or equivalent qualification).

Application forms and further details from the Chief Administrative Officer, Brighton Technical College, Pelham Street, Brighton BN1 4FA. (Telephone Brighton 685971).

Closing date—10 days after date of advertisement.

KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

(University of London)
Denmark Hill, London
SE5 8RX

JUNIOR TECHNICIAN

required to assist Doctors with clinical investigations with patients in an expanding and interesting field of hospital medicine. Training will be given to suitable applicants. Apply to the Secretary of the Medical School.

LABORATORY TECHNICIAN

(Grade 3) with mechanical and electronic skills required for general apparatus maintenance in Botany Department. Training in operation of electron microscope will be given. Applicants should have 2 appropriate A-level passes, or ONC or equivalent qualification. Salary on scale £2423-£2753 including London Weighting. Apply, stating age, qualifications, experience and two referees, to Administrative Assistant (NS30/1), Birkbeck College, Malet Street, London WC1E 7HX.

SENIOR ANALYTICAL TECHNICIAN

There is a vacancy in the Research Department of The Boots Company Limited in Nottingham for a suitably qualified and experienced analytical technician. The post is concerned with the measurement of drug concentrations in biological fluids in clinical studies of bioavailability.

Applicants should possess HNC or HND or an equivalent qualification, and should have substantial experience of modern analytical techniques, which must include Gas Chromatography. Previous experience with samples of biological origin is desirable but not essential.

Please apply for an application form to: Mrs E. M. Durrance, The Boots Company Ltd., Employment Services, Station Street, Nottingham.

UNIVERSITY OF GLASGOW

Department of Child Health

RESEARCH ASSISTANT

Applications are invited from suitably qualified science graduates to become a member of a team studying cystic fibrosis. The successful candidate will be expected to undertake studies of gut function and to use the data towards the degree of PhD.

Further information from and applications, with names of two referees, to Dr William Hamilton, Royal Hospital for Sick Children, Yorkhill, Glasgow G3 8SJ.

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MEDICAL RESEARCH COUNCIL

LABORATORY ANIMALS CENTRE

Carshalton, Surrey

Applications are invited from biology or zoology graduates (minimum age 28) with at least five years' postgraduate experience for a post of

TECHNICAL OFFICER

in the Centre's Accreditation department. Duties will include visiting commercial breeders of laboratory animals throughout Great Britain who are accredited or recognised by the Centre.

The successful applicant must be prepared to travel and spend up to six nights per month away from home.

Previous experience with small animals would be an advantage, but not essential. Salary within range £2688-£3792 p.a. plus London Weighting and threshold agreement. Superannuation scheme. Four weeks and two days holiday. Social and sports facilities.

Applications, together with a copy of curriculum vitae and the names of two professional referees, should be addressed to The Director, Medical Research Council, Laboratory Animals Centre, Woodmansterne Road, Carshalton, Surrey.

UNIVERSITY OF KHARTOUM—SUDAN

Applications are invited for post of

(a) Professor or

(b) Senior Lecturer in

Department of Horticulture

Faculty of Agriculture.

Salary scales: (a) £S4135 p.a. (b) £S2465-£S3000 p.a. (£1 sterling=£S0·80. The British Government may supplement salary in range £2076-£2346 p.a. (sterling) for married appointee or £1008-£1200 p.a. (sterling) for single appointee (normally free of all tax) and provide children's education allowances and holiday visit passages. Family passages; various allowances; superannuation scheme; annual overseas leave. Detailed applications (2 copies), including a curriculum vitae and naming 3 referees, should be sent by airmail, not later than 28 February 1974 to the Personnel Secretary, University of Khartoum, PO Box 321, Khartoum, Sudan. Applicants resident in UK should also send one copy to Inter-University Council, 90/91 Tottenham Court Road, London W1P 0DT. Further particulars may be obtained from either address.

UNIVERSITY OF LONDON KING'S COLLEGE

POSTDOCTORAL RESEARCH ASSISTANTSHIP

Applications are invited for a POSTDOCTORAL RESEARCH ASSISTANTSHIP. The person appointed will have a PhD or equivalent in Biological Sciences with interests in Biophysics or Bioelectronics, and if possible research experience in interactions of electromagnetic radiation with living systems. The research project is to study such effects over a range of electromagnetic frequencies.

The post is tenable for one year in the first instance from 31 March 1975 or as soon as possible thereafter.

The salary will be at an appropriate point on the scale £2118 to £2500 plus London allowance. USS contributions will be payable.

Applications by letter, giving curriculum vitae and naming two referees to the Registrar, University of London King's College, Strand, London WC2R 2LS, by 1 March 1975. Quoting reference NS 6/2.

Materials Engineering

in a developing environment

Materials Engineers are required to work with a team of qualified technologists in our Materials Laboratory. The team provides technical support for engineers engaged in the development and manufacture of Spacecraft, Underwater and Military Communications equipments.

Metallurgist

This position involves responsibility for providing metallurgical control and the selection of materials for use in advanced manufacturing and development programmes. Applicants should ideally have experience of micro-welding, soldering, brazing or plating techniques, although new graduates will be considered for the post.

Materials/Standards Engineer

Applicants should have a wide knowledge of materials, both metallic and non-metallic as well as experience in the use of military and aerospace standards. Experience in the writing of materials and process specifications would also be an advantage.

Successful candidates for these positions are likely to have professional qualifications to degree level or equivalent in Metallurgy, Chemistry or Materials Science.

Competitive salaries are offered, based on age and experience, with other excellent conditions of employment and big-company benefits.

Please write or telephone to: Mr D. Miller (Senior Personnel Officer), Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Portsmouth. Tel: Portsmouth 64966 ext 40.

Marconi
Space & Defence
Systems A GEC-Marconi Electronics Company

ROYAL FREE HOSPITAL HAMPSTEAD

MEDICAL PHYSICS

TECHNICIAN (Electronics)

A vacancy exists in the Electronics Workshop of this brand new major Teaching Hospital. Applicants should hold the final City and Guilds or an equivalent qualification. Some knowledge of analogue and digital circuit techniques desirable.

Salary on a scale £2314 – £3004 dependent on qualifications and experience.

Application forms, to be returned by 15th February 1975, from the Personnel Department, Royal Free Hospital, 21 Pond Street, London NW3.
Tel: 01-794 0431.

CENTRAL PUBLIC HEALTH LABORATORY

HONOURS SCIENCE GRADUATE

This is a vacancy for an Honours Science Graduate, preferably in microbiology, in the Salmonella and Shigella Reference Laboratory. The successful applicant will work in the E.coli-Shigella Section of this Laboratory. The post provides excellent training in the most up-to-date methods of E.coli and Shigella identification. Applications to Personnel Officer, Central Public Health Laboratory, Colindale Avenue, London NW9 5HT.

THE UNIVERSITY COLLEGE OF WALES ABERYSTWYTH

Edward Davies Chemical Laboratories

ASSISTANT FOR DIELECTRICS RESEARCH

To assist and develop new aspects of dielectric studies: in particular to control and use microwave sweep-frequency and pulsed high-field methods for dielectric studies. Honours graduate in Physics or Electronic Engineering, etc., with good practical competence and initiative. Appointment for up to three years.

Salary: £2000 pa + FSSU.

Details and application forms from the Registrar, University College of Wales, Aberystwyth, SY23 2AX: to be returned before 31 March 1975.

The Polytechnic of North London

Holloway Road, London N.7

NATIONAL COLLEGE OF RUBBER TECHNOLOGY

Lecturer II in Plastics Technology

Immediate applications are invited for a teaching appointment as a Lecturer II in Plastics Technology. Applicants must be qualified polymer chemists or chemical technologists with industrial experience of polymer processing technology. The post will provide opportunities for personal and team research in polymer technology.

Salary Scale—£2700–£3474 (Under Review) plus £351 London Allowance. In addition, the Threshold Agreement is applicable.

Apply for application form and further details to

The Deputy Establishment Officer, The Polytechnic of North London, Holloway Road, London N7.

LONDON BOROUGH OF BARNET EDUCATION DEPARTMENT

SENIOR LABORATORY TECHNICIAN

(Grade T1)

required at Moat Mount Secondary School, Worcester Crescent, NW7. Applicants should have several years experience and preferably have passed the City and Guilds Science Laboratory Certificate (or equivalent) for which an additional salary allowance will be made. Excellent laboratory facilities. Duties include supervision of laboratory technicians, construction of apparatus, assembly, care, maintenance and operation of equipment including visual/aural aids, use of chemicals, upkeep of stock records, etc. Five-day, 36 hour week. Permanent superannuable post. Commencing salary within range £1992–£2127 per annum, including London Weighting; plus cost of living 'threshold' allowance (currently approximately £229 per annum). Prescribed conditions. Additional payment for recognised qualifications.

Application form from Director of Educational Services, Town Hall, Friern Barnet, N11 3DL (ref: ADM/S/547a).

R. H. WILLIAMS
Chief Executive and Town Clerk

YORKSHIRE WATER AUTHORITY

Directorate of Operations (Scientific Services)

ASSISTANT SCIENTIFIC and TECHNICAL OFFICER

£2613 to £3063, plus Threshold Payments

The post is based at Olympia House, Gelderd Road, Leeds.

A new member is required for a team working on the development and optimization of water and sewage treatment processes. The team is engaged both in work at Head Office Laboratory and in on-site work.

Candidates should possess a Degree or H.N.C. in Chemistry, Chemical Engineering or some other appropriate Scientific or Engineering discipline. Experience of plant optimization or pilot plant work in either the Water or Chemical Industry would be a great advantage.

Application forms are available from **The Personnel Officer, Yorkshire Water Authority, West Riding House, 67 Albion Street, Leeds LS1 5AA,** to whom they should be returned by 27th February 1975 quoting RN. 131/NS.

YORKSHIRE WATER AUTHORITY

NATURAL ENVIRONMENT RESEARCH COUNCIL BRITISH ANTARCTIC SURVEY

SOIL INVERTEBRATE ECOLOGIST

There is a vacancy for a zoologist to study either the nematodes or rotifers of selected terrestrial sites as part of a long-term ecosystem project. In either case, the work will involve population ecology, respiration and feeding studies.

Applications are invited from good honours graduates and the appointment is for 2½ years' field work based at the British Antarctic Survey research station at Signy Island, South Orkney Islands. The commencement date is March/April 1975 and following a period of preparation based at Monks Wood Experimental Station, the individual will sail for the Antarctic in the autumn of 1975. On his return to this country, he will write up the work with the Survey in Cambridge.

Salary in range £2012–£3121 per annum. Closing date for applications—22nd February, 1975. Application forms and further details from:

British Antarctic Survey
Monks Wood Experimental Station
Abbots Ripton, Hunts
Tel: Abbots Ripton 381

CHEMISTS

Pyrene Chemical Services Limited, the leading U.K. supplier of metal pretreatment chemicals has vacancies for chemists in the Research and Development Section of their Laboratories at Iver, Bucks.

Applicants should be of B.Sc. H.N.C. or equivalent level and while experience in surface coating technology would be an advantage it is not essential.

Application forms are available from:—

PYRENE

Personnel Department,
PYRENE CHEMICAL SERVICES LIMITED,
Ridgeway,
Iver, Bucks.

Is a member of the Brent Chemicals International Group

WHITBREAD
LONDON LIMITED

LABORATORY ASSISTANT

At the Whitbread Brewery in Leagrave, we brew a broad range of National Beers, which are subsequently packaged on high speed lines.

To check that the highest standards are being maintained from the raw materials to the packaged product, we operate a modern, comprehensive Quality Control Laboratory, staffed by a young team of Laboratory Assistants.

We have a vacancy for a young man or woman to be trained as a member of the Quality Control team.

Candidates should have received a good basic education, especially in Chemistry and Biology.

The rewards for working with Whitbread are attractive, and the job is varied and challenging.

Applications should be made, in writing, outlining qualifications and career to date, to:

D. S. E. Jones,
Personnel Manager,
Whitbread London Limited,
Oakley Road,
Luton,
Beds.

Centre for Overseas Pest Research
London

Micrometeorologist

■ Join team investigating the control of agricultural pests in tropical countries ■ Topics under consideration include studies of the atmospheric boundary layer, the diffusion of droplet and vapour plumes or the dispersion of airborne insect pests within crops ■ Short-term visits overseas as member of project team.

☐ 1st/2nd hons degree in physics or environmental sciences ☐ Some experience in above subjects, preferably meteorology ☐ Age normally under 32 ☐ Appointments as Senior Scientific Officer (around £3800 to over £5050), Higher Scientific Officer (£3100 to over £4000) or Scientific Officer (over £2200 to £3300) according to age, qualifications and experience ☐ Ref: SA/24/JA.

■ *Application forms (for return by 28 February 1975) from Administrative Secretary, Centre for Overseas Pest Research, College House, Wrights Lane, London W8 5SJ.*

Ministry of Defence
Military Vehicles and Engineering Establishment, Chertsey

Computer Shift Leader

■ To assist with implementation of new ICL 1903T computer with 96K core and remote control entry facility ■ Supervise running of shift ■ Duties include staff training, setting up operating standards scheduling, user liaison and upkeep of George 3.

☐ Degree, HNC or equivalent in appropriate scientific subject ☐ Experience of operating 1900 series essential ☐ Knowledge of George 3 an advantage ☐ Age under 27 ☐ Appointment as Scientific Officer (over £2050 to £3150) ☐ Ref: SA/4/FR.

■ *Application forms (for return by 28 February 1975) from Personnel Officer, Military Vehicles and Engineering Establishment, Chertsey, Surrey.*

Science group
CIVIL SERVICE

Beecham Pharmaceuticals

Challenging Opportunity-

in our team of Medical Information and Services specialists

This post provides an outstanding opportunity for a person with imagination and initiative to join a vigorous and developing department within one of the leading British pharmaceutical companies.
We require someone able to make a positive contribution to all aspects of the very varied work of a busy department. Increasing emphasis is being placed on the development of tailor made information services for colleagues in the UK and overseas. The duties would include abstracting, the drafting of information papers and summaries for internal publication, the answering of technical queries from the medical and allied professions, and liaison with research and marketing colleagues.
After a period of familiarisation and training the person appointed would be expected to take increasing responsibility for a specific aspect of the work of the department.
The successful candidate will be a graduate in pharmacy or a related field, with a lively and enquiring mind. The ability to communicate lucidly, both verbally and in writing, and to work effectively with colleagues in various departments are regarded as important qualifications. Previous experience would be an advantage but not a necessity, as full training will be given. The salary is attractive and the company operates non-contributory pension and free life insurance schemes.
Please write giving brief career and personal details to the Personnel Manager Commercial and Administrative Departments, Beecham Pharmaceuticals UK Division, Beecham House, Great West Road, Brentford, Middlesex, TW8 9BD.

THE QUEENS
AWARD TO INDUSTRY
1966 1970 1971 1972.

UNIVERSITY OF EDINBURGH

Department of Fire Engineering

RESEARCH ASSOCIATE

Applications are invited from graduates in engineering or the applied sciences for work on smoke control in buildings. The research is sponsored by the Science Research Council and a two-year contract is available.

Starting salary £2118 per annum.

Further information may be obtained from, and letters of application sent to, Eric W. Marchant, Department of Fire Engineering, University of Edinburgh, King's Buildings, Edinburgh EH9 3JL. (Telephone 031-667-1081, ext. 3616). Please quote reference 5004.

THE ROYAL VETERINARY COLLEGE

(University of London)
Department of Animal Husbandry & Hygiene

Boltons Park, Hawkshead Road, Potters Bar, Herts.

TECHNICIAN GRADE 3

required for laboratory work on animal nutrition, both teaching and research. Training and experience should preferably be in chemistry and biology or biochemistry and physiology. Applicants must hold intermediate IMLT, IST or other suitable qualifications.

Salary scale £2273 to £2603 p.a. (inclusive of London weighting).

Applications to: Assistant Secretary (Personnel), The Royal Veterinary College, Royal College Street, London NW1 0TU.

NORTH LONDON SCIENCE CENTRE

62-66 Highbury Grove, N5

LABORATORY TECHNICIAN GRADE 3

required. Qualifications required OND or ONC or 2 'A' levels or Ordinary City & Guilds or equivalent, and at least 3 years' experience (including training period). 35 hour week. The Centre is concerned primarily with 'In Service' training of science teachers. Salary £2013-£2343+£411 London Weighting.

Applications forms and details from the Secretary, returnable within 2 weeks.

LIVERPOOL POLYTECHNIC

School of Pharmacy

LECTURER II in PHARMACOLOGY

Applications are invited from graduates in Pharmacy or Pharmacology for the post of Lecturer II in Pharmacology. Applicants should hold a higher degree and relevant post-doctoral experience would be an advantage. The person appointed will be expected to teach pharmacology to honours degree students and to engage actively in research.

SALARY: £2700-£3474 (under Houghton Committee review) plus threshold. Starting point dependent upon previous experience.

Details available from Staff Office, Dept NS, Liverpool Polytechnic, Richmond House, 1 Rumford Place, Liverpool L3 9RH.

INSTITUTE OF GEOLOGICAL SCIENCES

SCIENTISTS

The Institute has vacancies for Scientific Officers, Higher Scientific Officers and Senior Scientific Officers. Appointment will be for an initial period of three years with the possibility of appointment to a permanent pensionable post at a later date. All staff are liable for overseas service.

1. APPLIED GEOPHYSICS UNIT—based in London. Ref. SO/AGU/75

Seismic Interpreters	to join a team engaged in the compilation and interpretation of commercial marine seismic reflection data, with a view to producing maps of regional structure of areas of hydrocarbon potential around the UK. Commercial experience an advantage.
Geophysicists	for regional surveys, structural studies, economic surveys and research into the improvement of field and interpretative techniques.
Prospecting Geophysicists	for a programme of mineral exploration in the UK on which a whole range of geophysical methods are being used.

2. MARINE GEOPHYSICS UNIT—based in Edinburgh. Ref SO/MGU/75

Applications Programmer	A computer Programmer with scientific applications experience. Duties will include maintaining and updating software for geophysical applications and its incorporation into the Institute's data base. In addition the programmer will be required to develop applications programmes in data retrieval, analysis and display.

Minimum Qualifications

Scientific Officer	Posts under 1. A degree, HNC or equivalent qualification in Geology, Physics or related subject. Post under 2. A suitable degree plus relevant computing experience.
Higher Scientific and Senior Scientific Officer	As above plus at least two years appropriate postgraduate or other approved experience for HSO and four years for SSO.

Age

SO	normally under 27
HSO	normally under 30
SSO	normally at least 25 and under 32

Salaries

Scientific Officer	£1592–£2675
Higher Scientific Officer	£2461–£3371
Senior Scientific Officer	£3157–£4441

Posts based in London attract Inner London weighting at £410 per annum. All posts attract the current threshold agreement payment of £19.14 per month.

The staff of the Council are not Civil Servants but their pay and conditions of service are similar to those of Scientists in the Civil Service.

Application forms, which should be returned not later than Friday 21st February 1975, are available from Hugh Brookes, Establishments Section, Institute of Geological Sciences, Exhibition Road, London SW7 2DE.
Please quote appropriate reference number.

Reactor Physics Team Assistant

£2,075 - £3,300 plus Threshold payment

Hinkley Power Station, situated on the North Somerset Coast has an opportunity for a Science Graduate to join the Reactor Physics team.

This team is responsible for ensuring that the two 'Magnox' Reactors and the two 'Advanced Gas-Cooled Reactors' are operated in a safe and efficient manner. Initially, the main task of the job holder will be to collect and analyse various data to achieve this objective. Opportunities will be given to work in other sections to assist individual career development, depending on local circumstances.

Applicants should possess a degree or equivalent in Physics, Mathematics or Engineering, and a logical, analytical mind. Previous experience is not essential.

Conditions of service include five weeks annual holiday, a non-contributory pension scheme and a social club.

Application forms may be obtained by Telephoning Bristol 32251 ext 324 or by letter to the Personnel Manager, and should be returned to him quoting vacancy number 25/75/NS. By not later than 20th February.

Central Electricity Generating Board
South Western Region
Oakfield Grove, Clifton,
Bristol BS8 2AS

LEICESTERSHIRE MUSEUMS, ART GALLERIES AND RECORDS SERVICE

ASSISTANT KEEPER (TECHNICAL SERVICES) BIOLOGY

Salary: AP3/4 (£2473-£3109 p.a. including threshold payment). Responsible for all technical services relating to the biological collections and displays, other than the botanic gardens. Applicants should be experienced technicians with an interest in training and the development of new techniques. Generous removal and resettlement allowances will be paid.

For full details and application forms please write or telephone: P. J. Boylan, Director of Museums, Art Galleries and Records Service, Leicestershire Museum, New Walk, Leicester LE1 6TD (tel: 0533 539111—Ext. 292).

Completed application forms should reach me by 28 February.

BIRKBECK COLLEGE

University of London
Department of Economics

Vacancies exist for

RESEARCH ASSISTANTS

to work on a number of projects financed by the SSRC and other organisations. Appointments for periods of up to two years: Salaries within range £1915-£2641 p.a. (under review) depending upon qualifications and experience.

Application forms and full details from Deputy Secretary (NS030/1), Birkbeck College Malet Street, London WC1E 7HX.

ICI CORPORATE LABORATORY

CELL BIOLOGIST

The ICI Corporate Laboratory requires a Cell Biologist to join the Bioscience Group. This is a multidisciplinary team carrying out fundamental research and seeking novel applications of biological science. The scientist we want will be at postdoctoral or doctoral level but not older than thirty. He or she will bring to the Group experience of cell or tissue culture, but will be expected to contribute to a wide range of programmes. The work will demand highly motivated and creative people who enjoy long-term research in a closely knit team.

The Laboratory is one of ICI's central research laboratories: it affords the opportunity of living within easy access of the Lake District, the Peak District, North Wales and the cities of Chester, Liverpool and Manchester, yet London is only 2¼ hours away.

Interested applicants who are still at University should contact their Appointments Board initially to see if Company recruiters are visiting. Otherwise, please write for an application form to:

Mr. D. J. Allan
Personnel Officer
ICI Corporate Laboratory
PO Box 11
The Heath, Runcorn
Cheshire WA7 4QE

INNER LONDON EDUCATION AUTHORITY

Putney College for
Further Education
50-52 Putney Hill,
London SW15 6QX

LABORATORY TECHNICIAN Grade 5

required to take charge of three chemistry laboratories. Qualifications required HNC, HND or Advanced City and Guilds or equivalent. At least eight years' experience (including training). Salary £2439-£2895 plus £261 London Weighting.

LABORATORY TECHNICIAN Grade 3

required for Biology. Qualifications required, ONC, or OND or two "A" levels or equivalent. At least three years' experience (including training). Salary £2013-£2343 plus £261 London Weighting.

LABORATORY TECHNICIAN 1B

required for Physics. Qualifications required CSE/GCE in related subjects plus up to one year's experience. Salary £1692-£1839 plus £261 London Weighting.

Thirty-five hour week for each post. Application forms available from the SAO to be returned within 14 days.

ST. HELIER HOSPITAL

Carshalton, Surrey

MEDICAL PHYSICS TECHNICIAN GRADE II

required for District Medical Physics Department. Salary scale from £2601 to £3390 p.a. plus £312 London Weighting Allowance. Further details can be obtained from Chief Technical Officer—01-644 4343.

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

ROYAL POSTGRADUATE MEDICAL SCHOOL & INSTITUTE OF CHILD HEALTH

Department of Medical Physics and Paediatrics

RESEARCH FELLOW

required for development of instrumentation and research in a clinical team concerned with the investigation and intensive care of sick newborn infants and children. There is particular interest in cardiopulmonary physiology and the analysis of arterial blood gases in the servo control of the treatment.

Applicants should hold appropriate degree qualification in Physics or Electronic Engineering, and have practical ability and experience relevant to this field.

Initial salary in range up to £3108 per annum+£399 London Allowance +threshold.

The post is available for one year in the first instance with the possibility of an extension for a further 2 years.

Applications, with full c.v., naming 2 referees to the Personnel Officer, RPMS, Hammarsmith Hospital, DuCane Road, London W12 0HS, quoting ref. no. 8/220.

CENTRE FOR OVERSEAS PEST RESEARCH

London

JUNIOR RESEARCH FELLOWSHIP

The Division of Ecology has a vacancy for a Junior Research Fellow to work on continental scale displacements of Desert Locusts in relation to wind patterns. The fellow will be expected to register this work for a higher degree at the Department of Geography, Bedford College, University of London. The post is in London, and would be particularly suitable for a recent honours graduate in Geography, or someone expecting to graduate this summer, who has a particular interest in biogeography and meteorology.

The fellowship is valued at £2191 per annum plus Inner London Weighting (£410 p.a.) and is tenable for three years only. Further details and application forms can be obtained from Administrative Secretary, Centre for Overseas Pest Research, College House, Wrights Lane, London W8 5SJ quoting COPR/3/4/68.

Closing date for the receipt of completed applications is 3 March, 1975.

UNIVERSITY OF LONDON KING'S COLLEGE

POSTDOCTORAL RESEARCH FELLOWSHIP

Applications are invited for a POSTDOCTORAL RESEARCH FELLOWSHIP. The successful applicant will have a PhD or equivalent in Electronics or Electrical Engineering and will have experience in working with electro-magnetic transmitting and receiving apparatus (low frequency preferred). The research involves the development of tunable low frequency generators and of sensitive measuring devices at these frequencies.

The appointment will be for one year in the first instance from 31 March, 1975 or as soon as possible thereafter, at a salary not exceeding £4500 plus London allowance. USS contribution will be payable.

Applications by letter, giving curriculum vitae and naming two referees to the Registrar, University of London King's College, Strand, London WC2R 2LS, by 10 March, 1975. Quoting reference NS6/2.

THE QUEEN'S UNIVERSITY OF BELFAST

DEPARTMENT OF BIOCHEMISTRY

ACTION CANCER RESEARCH FELLOWSHIP

Under a grant made available by Action Cancer to the Department of Biochemistry, applications are invited for a research fellowship to work on the metabolism of cytotoxic drugs used in combination chemotherapy of cancer. The research will be carried out in collaboration with the Chemotherapy Group at the Northern Ireland Radiotherapy Centre.

Initial objectives include the correlation of circulating levels of cytotoxic drugs with effectiveness and with toxicity so as to afford more efficient therapeutic control.

Applicants should have a Ph.D. degree in Biochemistry or appropriately allied discipline, or alternatively may have a primary degree with industrial experience in drug assay. The post is tenable for five years with a possibility of extension. A permanent career structure may ultimately be possible. The salary, incremental with FSSU/USS, will start at one of the first six points on the University Lecturer's Scale, £2118 – £2931, with threshold payments of £229 p.a., according to age and qualifications.

Applications including a full curriculum vitae and the names of two referees should be sent to The Personnel Officer, The Queen's University of Belfast, BT7 1NN, Northern Ireland, to arrive not later than 12th March 1975. (Please quote Ref. 75/N.S.).

THE UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY

MULLARD RESEARCH FELLOWSHIP

Applications are invited for the Mullard Research Fellowship, tenable for a period of 3 years in the Department of Electrical Engineering and Electronics at the University of Manchester Institute of Science and Technology. The person appointed would work in the Solid State Electronics group on the technology of metal semiconductor contacts, using the technique of Rutherford backscattering, Auger analysis and scanning electron microscopy to relate contact structures to device performance. The work would involve close collaboration with Mullard (ASM) Ltd., Hazel Grove. Candidates should have a PhD or equivalent postgraduate experience.

The salary would normally be in the range £2118-£2412 but a higher salary might be offered to an applicant of greater experience.

Further details may be obtained from the Registrar, UMIT, PO Box 88m Manchester M60 1QD to whom application should be made before February 22nd 1975.

THE UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY

RESEARCH IN CHEMISTRY

Research grants are available for British students, at postgraduate, post-Grad RIC level for research in the following areas.

(1) Medicinal Chemistry.
(2) Heterocyclic and Aromatic Chemistry.
(3) Organic Reaction Mechanisms.
(4) Free Radical Chemistry.
(5) Organic Photochemical Reactions.
(6) Organometallic Chemistry.
(7) Petrochemical Research.
(8) Polymer Synthesis and Reactions.
(9) Valence-bond Isomers.
(10) Application of the Woodward-Hoffmann Rules.
(11) Inorganic Polymers.
(12) Synthesis of perfumery and flavouring chemicals via cycloaddition reactions.
(13) Medicinal Applications of transition metal complexes.

Postgraduate, etc. grants range from £1000-£1400 per annum depending upon the topic.

MSc Course in Petrochemicals and Hydrocarbon Chemistry

The next course, which leads to the MSc Degree of the University of Manchester, starts on 1 October, 1975, and is open to Graduates in Chemistry or Chemical Engineering and to those with Grad RIC, Dip Tech or equivalent qualifications at an appropriate level of achievement. It consists of lectures, seminars, projects, tutorials, practical work, and a short research project, and some of the lectures are given by distinguished speakers from industry. The course, which is designed for those interested in petrochemistry, in the chemistry of petroleum, or in general hydrocarbon chemistry, has received support from the Petroleum and Chemical Industries, and is approved by the Science Research Council.

Applications should be sent as soon as possible after the appearance of this advertisement to: Professor R. N. Haszeldine, FRS, Department of Chemistry, UMIST, PO Box No 88, Sackville Street. Manchester M60 1QD.

THE NUFFIELD FOUNDATION

TRAVELLING FELLOWSHIPS IN MARINE BIOLOGY (TROPICAL AND SUB-TROPICAL)

The Nuffield Foundation offers a small number of fellowships each year to enable biologists in UK universities to travel overseas (normally for a period of between six and twelve months) to gain scientific experience of inshore marine environments in tropical and sub-tropical regions. Consideration can also be given to applications from physical scientists and from candidates who may be working in institutions other than universities. The primary aim of the scheme is to enliven and to broaden the scope of biology teaching at the tertiary level. The fellowships are open to men and women holders of UK or other Commonwealth university degrees. The value of the awards will be determined on an *ad hoc* basis but will cover fares, subsistence allowances, and contributions to equipment and running expenses.

Applications, for awards to be taken up in 1976, should be submitted by 31st March 1975. Further particulars and forms of application are available from the Nuffield Foundation, Nuffield Lodge, Regent's Park, London NW1 4RS.

UNIVERSITY OF KENT AT CANTERBURY

RESEARCH FELLOW IN THE BIOLOGICAL LABORATORY

Applications are invited for a Post-Doctoral Research Fellowship for work on a project funded by the SRC and now well advanced, concerning the structure and reaction mechanism of bacterial and fungal carboxymuconate cyclomerases involved in the biodegradation of the aromatic nucleus. Applicants should have an interest in enzymology and protein structure. Salary range £2118-£2580 plus threshold payment of £229. Application forms and further particulars may be obtained from the Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH. Please quote ref. A7/75. Closing date for applications 21 February, 1975.

THE UNIVERSITY OF LEEDS DEPARTMENT OF PHYSICS AND COLOUR CHEMISTRY

POST-DOCTORAL RESEARCH ASSISTANT IN POLYMER SPECTROSCOPY

Applications are invited for an S.R.C. research fellowship from suitably qualified candidates interested in joining an active research group studying the properties and micro-structure of polymers. The successful applicant would undertake research on molecular orientation in orientated polymers using infra-red, Raman and fluorescence spectroscopy.

The salary will be in the range £2118–£2247 plus F.S.S.U. and the appointment is for two years in the first instance. Although the post is available immediately, applications are encouraged from anyone who will be suitably qualified and available to start on or before 1st October 1975. They should be sent as soon as possible, accompanied by a curriculum vitae and the names and addresses of two referees, to Professor L. M. Ward, Department of Physics, The University of Leeds, Leeds LS2 9JT.

STUDENTSHIPS

THAMES POLYTECHNIC

SCHOOL OF BIOLOGICAL SCIENCES

RESEARCH STUDENT

Applications are invited for the post of research student in the Division of Physiology and Cell Biology. The successful applicant will join a group investigating the recovery of mammalian cultured cells from freezing stress and will be expected to register for a higher degree. Applicants should possess a good degree in a biological subject.

The post covers a grant of £1250 per annum plus National Health Insurance contributions.

Further particulars and form of application may be obtained from the **Secretary, Thames Polytechnic, Wellington Street, London SE18 6PF**, to whom completed applications should be returned by 11 February 1975.

UNIVERSITY OF LONDON

Institute of Psychiatry

RESEARCH STUDENTSHIPS IN NEUROCHEMISTRY

Applications are invited for MRC Training Scholarships leading to a PhD in Neurochemistry. An upper 2nd or 1st class degree is required. Research topics include studies on metabolic abnormalities in mental illness and the metabolism of cyclic AMP, neurotransmitters and energy intermediates in cerebral cortex preparations, subcellular fractions and nerve cells in tissue culture.

Applications should be made to the Secretary, Department of Biochemistry, Institute of Psychiatry, De Crespigny Park, London SE5 8AF, UK quoting reference RM/NS.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

SCOTTISH STATION

POST-GRADUATE STUDENTSHIP

Applications are invited for an ARC Post-graduate Research Studentship, tenable at the National Institute of Agricultural Engineering Scottish Station for work on the effect of tractor wheels and tracks on the pattern and magnitude of soil compaction in a soil tank and in the field.

Candidates must be British subjects normally resident in the United Kingdom and should have a first or upper second class Honours degree in Engineering, Agriculture or Science. Applications will be considered from those about to graduate but any award made will be conditional on the attainment of the required standard. Candidates should normally be under 27 years of age on 1st October 1975 but older candidates may be considered.

The award comprises a tax-free Maintenance Allowance of up to £800 p.a. according to circumstances. Approved University fees and some travelling expenses and dependant allowances where appropriate.

Full particulars obtainable from

The Secretary
N.I.A.E. Scottish Station
Bush Estate
Penicuik
Midlothian EH26 0PH

The closing date is 28th February 1975.

THE MEDICAL COLLEGE OF ST. BARTHOLOMEW'S HOSPITAL

(University of London)

West Smithfield,
London EC1A 7BE

Applications are invited from good honours graduates and those expecting to graduate in 1975 for

POSTGRADUATE RESEARCH ASSISTANTSHIPS and STUDENTSHIPS

in Biochemistry. Successful candidates will be registered for the degree of PhD. Topics include Immobilized Enzymes, Enzyme Mechanisms, Metabolic Control, Radiation Biochemistry and Natural Product Chemistry.

Enquiries to Professor E. M. Crook, Biochemistry Department, The Medical College of St Bartholomew's Hospital, Charterhouse Square, London, EC1M 6BQ.

UNIVERSITY OF GLASGOW

Department of Forensic Medicine

RESEARCH STUDENT

Research Student to read for PhD on the analysis of biological materials (Radio immuno assay, gas chromotography / mass spectrometry). Candidate must have a 1st or 2nd class honours degree in chemistry or biochemistry. The position is supported by a grant of £880 per annum plus fees.

Applications should be submitted, as soon as possible to Dr Hamilton Smith, Department of Forensic Medicine, the University of Glasgow, Glasgow G12 8QQ.

In reply please quote Ref. No. 3620 N.

PSYCHICAL RESEARCH STUDENTSHIP

The Perrott-Warrick Fund of Trinity College Cambridge provides grants to research students. Applications (4 copies) for year commencing 1 Oct 1975, by 14 Mar 1975, to Dr D. J. West, 7 West Road, Cambridge CB3 9TD, stating qualifications, experience, intended project, naming 3 referees. Favourable consideration to those accepted by a British University as graduate research students.

LECTURES, MEETINGS AND COURSES

OXFORD STUDY GROUPS WITH INDUSTRY

Research workers from industry or other research establishments are invited to Oxford for the week March 17-21, 1975, to discuss their research problems with members of both the University Mathematics and Computing Faculties and the Division of Numerical Analysis and Computing, National Physical Laboratory. The problems should involve either (i) the theory, formulation or numerical solution of differential equations or (ii) linear and non linear optimization or (iii) statistics and operational research.

Lectures will be given on relevant mathematical methods but as much time as possible will be made available for informal discussion. Would any research worker interested in attending please write for further details to the Study Group Secretary, Dr J. R. Ockendon, Mathematical Institute, 24-29 St. Giles, Oxford OX1 3LB. Closing date for applications, 20th Feb 1975.

UNIVERSITY OF SURREY

Department of Chemical Physics

NEW MSc PROGRAMMES IN CHEMICAL PHYSICS

The Department of Chemical Physics invites applications for enrolment, in October 1975, into programmes in branches of Chemical Physics, leading to the degree of MSc by examination and project. Four programmes, Applied Crystallography Crystal and Molecular Structure Determination, Crystallography and Spectroscopy, are offered, both full-time and by a day-release scheme. Applicants need not decide upon their choice of programme before the end of Term 1, as this term is common to all four programmes.

Entrance qualifications include a first degree in one of the physical sciences, or an equivalent qualification, such as Grad RIC, or Grad InstP. A small number of SRC Advanced Course Studentships may be available. Further details and application forms may be obtained from Dr D. Lewis, Department of Chemical Physics, University of Surrey, Guildford, Surrey GU2 5XH.

THE UNIVERSITY OF MANCHESTER
INSTITUTE OF SCIENCE AND TECHNOLOGY

POSTGRADUATE COURSE IN SOLID-STATE ELECTRONICS (MSc and PhD)

A twelve-month postgraduate course in Solid-State Electronics will be held in the Institute commencing in October each year. The aim of the course is to give graduates in physics, electrical engineering or related subjects a thorough background of general solid-state physics, together with a detailed knowledge of those properties of solids which are of importance in electronics, and an introduction to the specialised techniques involved in the manufacture of devices.

Subjects to be covered include Semiconductors, Dielectrics, Magnetic Materials, Superconductors, Preparation and Purification of Materials, Design of Solid State Devices (Diodes, Transistors, Integrated Circuits, Lasers, Ferrite Cores, etc).

The course comprises two terms of lectures and laboratory instruction, leading to a written examination at the beginning of the Summer Term. Candidates for the degree of MSc subsequently undertake a research project on which a dissertation is normally submitted in October or later. Suitable candidates may be given the opportunity to proceed to PhD work, and enrolment on the MSc course is the usual method of entry to PhD research in this field.

The course is recognised by the Science Research Council and has an allocation of their studentships.

Further information may be obtained from Professor A. C. Rose-Innes, Department of Electrical Engineering and Electronics, UMIST, Manchester M60 1QD.

MAKE SCIENCE YOUR MAIN INTEREST IN A NEW-STYLE COURSE

Form part of informed opinion in a technological society by combining SCIENCE with Education or one of 21 other subjects at the new

ROEHAMPTON INSTITUTE OF HIGHER EDUCATION

From September, four Colleges of Education (Digby Stuart, Froebel, Southlands, Whitelands), set in extensive and attractive grounds adjacent to Richmond Park and Wimbledon Common and close to the rich resources of the London area, join forces to offer courses for intending teachers *and* those interested in other careers. The 20 scientists will provide flexible unit-based courses covering Biology, Social Biology, Chemistry, Environmental Science, Natural Science, Physics and Physical Science. Combined with units from other subjects, these lead to award of various London University degrees, diplomas and certificates.

Details from **Natural Science Dept., Froebel Institute, Roehampton Lane, London, S.W.15.**

INSTITUTES OF PSYCHIATRY, NEUROLOGY AND OPTHALMOLOGY

(British Postgraduate Medical Federation, University of London)

POSTGRADUATE COURSE IN NEUROCHEMISTRY

This is a ONE-YEAR Course leading to the degree of MSc in Neurochemistry. It offers graduates in science and medicine training in basic and applied neurochemistry. The Course consists of lectures, seminars and laboratory work and, in the second and third terms, research on a neurochemical topic.

Applicants should have a First or Second Class Honours degree in Biochemistry or a cognate subject, or be medically qualified. The Course is recognised by the Medical Research Council as an Advanced Course for the award of Training Fellowships to suitably qualified medical applicants, who should apply as soon as possible.

Application for the Academic year October 1975-July 1976 should be addressed to the Secretary, Course in Neurochemistry, Department of Biochemistry, Institute of Psychiatry, De Crespigny Park, Denmark Hill LONDON SE5 8AF, England. Tel: 01-703 5411. Quoting reference RM/NS.

UNIVERSITY OF OXFORD

MSc in the Science and Applications of Electric Plasmas

A course of one year's duration, leading to the MSc in The Science and Applications of Electric Plasmas, is held annually. It is concerned with Ionization Phenomena in Gases, Fundamental Properties of Plasmas and Practical Applications; it includes experimental work, part of which is done at the Culham Laboratory of the UKAEA. The teaching is carried out by the staff of the Department of Engineering Science and by invited scientists from government laboratories and industry.

Applications are invited for the course beginning in October, 1975 from candidates who have a good honours degree in Engineering, Physics or Mathematics (or a comparable qualification), or expect to qualify in 1975.

The course is a valuable preparation for DPhil candidates, who normally require an additional two years of research.

Applications and enquiries should be sent to the Secretary, MSc course in Electric Plasmas, Engineering Science Laboratory, Parks Road, Oxford OX1 3PJ.

INSTITUTE OF OPHTHALMOLOGY

(University of London)

COURSE ON LASER HAZARDS

A two-day course on Laser Hazards for those concerned in laser operations, including Ophthalmologists, Safety Officers, Industrial Medical Officers and those professionally concerned with laser radiation hazards, will be held from 9.30 am to 5.00 pm on 3 and 4 April, 1975, at the Institute of Ophthalmology, Judd Street, London, WC1H 9QS.

Topics to be discussed will include: laser epidemiology, coherent and incoherent optical radiation, target tissues, ocular and dermatological hazards, metrology, administration of safety codes, relevant pathology and medico-legal aspects, etc. Facilities will be provided for open discussion and clinico-pathological illustrations. Attendance fee of £30 will include buffet lunch, coffee and tea on both days. Early application is advised. Number limited to 50.

Application forms obtainable from The Dean, Institute of Ophthalmology, Judd Street, London, WC1H 9QS.

Cranfield

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Ariadne

I'm more than a little baffled by the government's timid approach to energy-saving. Those doubtless expensive exhortations on commercial television are pitched so softly, so ingratiatingly that you feel the crisis can't be all that serious. Perhaps it has been decided to deal with the oil deficit in some fiendishly subtle way that would be incomprehensible to the man in the street and the "save a watt" campaign is mere window dressing. Perhaps we are struggling to preserve an economy that may even depend on wastefulness for its very existence, as Vance Packard and others have suggested. The ambivalent attitude towards recycling may be further proof. How much of international trade is simply shifting short-lived artifacts around? It is interesting even if irrelevant to compare how the Chinese revolutionaries are making ends meet. A Shanghai chemical works (Reuter reports) collected 600 tons of grease over a three-year period from the dish water of the city's restaurants and from this extracted enough pure oil to make three million bars of soap. A collection of cigarette ends was turned into enough pesticide to treat 1500 acres of farmland. Film studio workers in 1973 salved 10 000 ozs of silver from the film development process. These examples will doubtless make the sophisticates fall about but they leave me with a feeling of uneasiness that we may not, after all, be so damn smart.

■

That old bogey, the dum-dum bullet, is in the news again. The Home Secretary, it appears, has thought better of accepting a working party's advice that they be supplied to the police. The argument in their favour is that they do not ricochet and can therefore be used in a crowded place with less risk to the innocent bystanders. They also leave a very large exit wound and as such would seem to be expressly forbidden by the Geneva convention which prohibits weapons causing "superfluous injury". No army would admit to their manufacture but the OED Supplement (vol 1) quotes the Westminster Gazette of 1899 as saying, "Any man can 'Dum-Dum' his own cartridges in a very few minutes by merely filing the nickel envelope off the nose of the bullet." Each side accused the other of using dum-dums in the 1914-1918 war and, in the Irish Troubles that followed the "sack of Balbriggan" by the Black and Tans was put down to the emotions aroused by the appearance of the corpse of an RIC district inspector on whom the IRA had used dum-dums. I recall a scare during the 1939-1945 affair when British aircrews were advised not to carry ·45 Colt automatics. The copper-nosed ball-shaped ammunition was said to be regarded by the Germans as falling into the forbidden category.

■

A rather nice idea from the other side of the Atlantic is reported in Computerworld (15 January). Two Harvard students have set up an organisation called Computer-Hitch which collects the names of members intending to hitch a lift and matches them with those of motorists going in the right direction at the right time. Students—they come from more than 25 colleges in the Boston area—pay $2 a year plus a 50 cents fee per match. Next year the idea spreads to New York and eventually its originators hope to see it reach from coast-to-coast. Except that by then no one will be driving anywhere, the idea seems an excellent one; it can easily be adapted to finding a place on the wagon trains.

■

Knowing my appetite for slush words, a Cambridge reader has sent me a copy of a come-on for some conference or other in Palo Alto, California. Rooms, it says, have been reserved in an hotel "which is suitably equipped with gustatory and social amenities". Mr Ron Ziegler, who I notice has now left San Clemente and returned to the real world, couldn't have done better.

■

The mighty sales of deodorants, talcum powders, etc., intrigues my aquamotive friend Daedalus. Sweat is intended to cool the skin, but if impeded by clothing it may remain stagnant long enough to decompose, generating those distressing odours your best friends fail to mention. Daedalus once invented a shirt woven of fine bimetallic strip, which opened venetian-blind fashion to let the steam out when the wearer got hot, but shut tight in the cold: a sort of automatic climate control. He now returns to the field with his new "electric sweat-shirt". It depends on electro-osmosis, the curious phenomenon by which water is impelled through a porous barrier if a voltage is maintained across it. (This happens because of a charged layer at the liquid-sold interface.) The shirt material has a transparent conducting coating on both sides, the inside forming one electrode and the outside the other. A servosystem in the wearer's pocket detects the humidity and temperature inside the shirt and adjusts the "pumping potential" across the cloth accordingly. The garment is in effect a personal air-conditioner. When the wearer is hot and sweaty, the servo increases the potential, and electro-osmosis rapidly pumps the accumulating moisture through the cloth, to evaporate from the outer surface. If he gets chilly, the potential drops or even reverses, drawing water-vapour in from outside to create a comfortable fug beneath the garment. Separate sensors and electroded areas enable problem regions like the armpits to receive special attention. All clothing can be equipped with electro-osmotic moisture-control: boots in particular, which for those with sweaty feet are the most refined torture, will at last enable the feet to "breathe" as they say—or more accurately give them artificial respiration. Deodorants and other clumsy forms of sweat-control will be needed no longer! A further advantage of electro-osmotic clothes will be apparent in rainstorms, where bursts of high voltage will "bale them out", the wearer briefly spraying out drops like a dog shaking himself. And the same auto-drying ability will make clothes-lines and tumble-driers a thing of the past.

Right now, Archie, shall we finish with a duet for the lovely ladies and gentlemen?

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Conference Objective

Britain's alarming economic state and particularly her difficulties with overseas suppliers of fuel, food and raw materials prompt this authoritative re-examination of our options. How far is it socially, technically and economically possible (and desirable) to reorganise our way of life to make us less dependent on imports? The chairman will be Professor Sir Michael Swann, FRS, Chairman, Board of Governors, BBC.

The speakers will include:

Dr Walter Marshall, FRS, Director of AERE Harwell and Chief Scientist at the Department of Energy, who will speak on energy.

Dr Kenneth Blaxter, FRS, Director of the Rowett Research Institute, Aberdeen, and Consultant Director of the Commonwealth Bureau of Nutrition, who will speak on food.

Sir Kingsley Dunham, FRS, Director of the Institute of Geological Sciences, London, who will deal with minerals.

Other speakers will consider imports of non-mineral raw materials and the social implications of possible changes that we might make in our economy.

Provisional programmes and application forms are now available and can be obtained from the address below.

To: The Conference Administrator, "Towards a Self-Sufficient Britain?", IPC Business and Industrial Training Ltd., 161-166 Fleet Street, London, EC4

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The only qualification for entry is that their work must have been published and be listed in the nomination, together with the names of two referees. All candidates must be British subjects.

Nominations should be sent to Dr. Magnus Pyke, Secretary of the British Association for the Advancement of Science, Fortress House, 23 Savile Row, London W1X 2AA and the closing date is 31st March 1975.

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